IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

NATIONAL STEEL CAR LIMITED, Plaintiff, v. FREIGHTCAR AMERICA, INC., Defendant.	)	**Redacted - Public Version** C.A. No. 24-594-JLH-CJB [redacted]

PLAINTIFF NATIONAL STEEL CAR LTD.'S UNOPPOSED MOTION FOR ISSUANCE OF LETTERS ROGATORY TO OBTAIN EVIDENCE

John W. Shaw (No. 3362)
Andrew E. Russell (No. 5382)
SHAW KELLER LLP
I.M. Pei Building
1105 North Market Street, 12th Floor
Wilmington, DE 19801
(302) 298-0700
jshaw@shawkeller.com
arussell@shawkeller.com
Attorneys for Plaintiff National Steel Car Limited

OF COUNSEL:
Safet Metjahic
Robert D. Keeler
ICE MILLER LLP
1500 Broadway, Suite 2900
New York, NY 10036
(212) 824-4940

Kenneth Sheehan
ICE MILLER LLP
200 Massachusetts Ave NW, Suite 400
Washington, DC 20001
(202) 824-8666

Dated: April 16, 2025

Plaintiff National Steel Car Ltd. ("NSC") moves the Court unopposed for issuance of the attached Letters Rogatory to the appropriate authorities of Canada pursuant to Federal Rules of Civil Procedure Rules 4(f)(2)(B) and 28(b), the All Writs Act, 28 U.S.C. § 1651, and 28 U.S.C. § 1781(b)(2) (permitting the transmittal of letters rogatory through the district courts and the Department of State).

The Letters Rogatory, attached as Exhibit A, request production of certain documents and certain testimony from Canadian National Railway Company ("CN"), a Canadian Company, which purchased the infringing 600 open-top, bottom-discharge railcars described in the Second Amended Complaint (D.I. 56, the "Accused Products") from Defendants FreightCar America, Inc., FreightCar North America, LLC, JAC Operations Inc., and FCA-FASEMEX, LLC ("FreightCar"). The requests to Canada are also made pursuant to the Quebec Code of Civil Procedure c. 504-506 and the Canada Evidence Act, R.S.C., 1985, c. C-5.

I. Background

Plaintiffs NSC alleges that FreightCar willfully infringed and infringes U.S. Patent Nos. 8,166,892 (the "'892 Patent") and 8,132,515 (the "'515 Patent", collectively with the '892 Patent the "Asserted Patents") by making, using, selling, offering for sale, and/or importing the Accused Products in connection with a sale to CN. (D.I. 56, "SAC" ¶¶ 132-174.)

In 2009, NSC manufactured and sold to CN 232 open-top bottom-discharge railcars ("the NSC Jennies") for use on CN's Duluth, Missabe and Iron Range Railway ("DMIR") railway. (SAC ¶¶ 18-29.) Features of these NSC Jennies were patented, and full drawings and specifications for the NSC Jennies were provided to CN. (*Id.*) In subsequent years, NSC bid on providing additional Jennies to CN and reiterated that its prior railcars included patented inventions. (*Id.* ¶¶ 30-38.)

However, NCS was not awarded any contracts for new open-top bottom-discharge railcars, which instead went to FreightCar. Subsequently, FreightCar made and delivered the Accused Products to CN. (*Id.* ¶¶ 38-39.) As detailed in the Second Amended Complaint, the Accused Products infringe the Asserted Patents, and are nearly dimensionally identical to the NSC Jennies. (*Id.* ¶¶ 132-174.)

[redacted]

NSC alleges that during the course of these meetings, knowledge of NSC's inventions and/or patents was shared between CN and FreightCar. (*See* SAC at ¶¶ 100-101.) NSC also believes that others may have bid on supplying railcars for use on the DMIR at this time.

As a result, NSC believes that communications between CN and others regarding the supply of railcars for use on the DMIR is likely to lead to the discovery of admissible evidence, at least regarding infringement, willfulness, and damages. Letters Rogatory to CN is therefore necessary and appropriate in this case.

II. Argument

A letter rogatory is a formal written request sent by a court to a foreign court asking that a witness residing within that foreign court's jurisdiction either provide documents, a deposition, or both for use in a pending action before the requesting court. *Intel Corp. v. Advanced Micro Devices, Inc.*, 542 U.S. 241, 247 n.1 (2004) ("A letter rogatory is the request by a domestic court

to a foreign court to take evidence from a certain witness."); *Barnes & Noble, Inc. v. LSI Corp.*, 2012 WL 1808849, at *1-*2 (N.D. Cal. 2012) (granting motion for issuance of letters rogatory seeking discovery from an entity in Taiwan); 8A Charles Alan Wright, Arthur R. Miller, & Richard L. Marcus, Federal Practice & Procedure § 2083 (3d ed. 2007). The decision to issue such a letter is within the Court's discretion. *U.S. v. Wedding*, No. 08-2386, 2009 WL 1329146, at *1 (S.D. Cal. May 13, 2009). The proper inquiry for issuance is whether the discovery sought complies with the liberal standard of Federal Rule of Civil Procedure 26. *DBMS Consultants Ltd. v. Comp. Assocs. Int'l, Inc.*, 131 F.R.D. 367, 369 (D. Mass. 1990) ("Under the liberal discovery provisions of the Federal Rules, parties may inquire through deposition as to matters whose admissability [sic] is not immediately apparent, as long as the inquiry is reasonably calculated to lead to the discovery of admissable [sic] evidence"); *see also Barnes & Noble*, 2012 WL 1808849, at *2 ("A court's decision whether to issue a letter rogatory . . . require[s] an application of Rule 28(b) in light of the scope of discovery provided for by the Federal Rules of Civil Procedure.").

The Canada Evidence Act specifically provides that a court outside of Canada may serve letters rogatory upon a Canadian court. R.S.C.1985, c. C-5 §§ 46, 51. Judicial assistance between the United States and Canada is also governed by Article 5 of the Vienna Convention on Consular Relations, dated April 24, 1963 ("Vienna Convention"), which provides that a letter rogatory is an appropriate method for requesting evidence located in a foreign state. Vienna Convention, art. 5(j); 21 U.S.T. 77; 596 U.N.T.S. 261; and T.I.A.S. 6820. Pursuant to these authorities, once a letter rogatory is sent by the State Department to the Appropriate Judicial Authority of Canada, the Judicial Authority of Canada has the power to transmit the letter to the relevant Canadian residents and entities. *Id.*; R.S.C.1985, c. C-5 §§ 46, 51.

Here, NSC's use of a letter rogatory is the appropriate and sanctioned method of obtaining discovery from Canadian residents and entities. Where a document custodian is located in a nation like Canada that is not a signatory to the Hague Convention on the Taking of Evidence Abroad in Civil or Commercial Matters, letters rogatory are particularly appropriate. *See, e.g., Avago Techs. Gen. IP PTE Ltd. v. Elan Microelectronics Corp.*, 2007 WL 1815472, at *1 (N.D. Cal. 2007) ("[T]he Taiwanese lawyers were residents of a foreign nation that is not a signatory to the Hague Convention. Therefore, the appropriate method for requiring their appearance is the letter rogatory."); *Netherby Ltd. v. Jones Apparel Grp. Inc.*, 2005 WL 1214345, at *1 (S.D.N.Y. 2005) (acknowledging that under Rule 28(b) of the Federal Rules of Civil Procedure, U.S. courts may issue letters rogatory for the purpose of taking discovery from Canada-based entities and granting motion for letters rogatory); *see also U.S. v. Walus*, 616 F.2d 283, 304 (7th Cir. 1980) (district court should have granted request by party for use of letter rogatory to obtain evidence located abroad that was relevant to party's case).

NSC's request for execution of the attached Letters Rogatory should be granted because CN is believed to have material, non-duplicative evidence, including communications regarding the bidding process that was ultimately awarded to FreightCar for the Accused Products. Accordingly, good cause exists to issue the draft Letters Rogatory to CN, attached as Exhibit A.

III. Conclusion

For the foregoing reasons, NSC respectfully requests the Court approve, date, sign, and seal the proposed Letters Rogatory accompanying NSC's Motion. The documents and topics for deposition requested by NSC are set forth in the proposed Letters Rogatory, which is attached as Exhibit A.

NSC further requests that, after the Court has signed the Letters Rogatory, the Clerk of Court authenticate the Court's signature under the seal of this Court, and that the executed and authenticated Letters Rogatory be returned by the Clerk to counsel for NSC for delivery to the proper authority.

WHEREFORE, NSC respectfully requests that the Court grant the Motion for the Issuance of Letters Rogatory, and execute and issue the attached Letters Rogatory.

/s/ Andrew E. Russell

John W. Shaw (No. 3362)
Andrew E. Russell (No. 5382)
SHAW KELLER LLP
I.M. Pei Building
1105 North Market Street, 12th Floor
Wilmington, DE 19801
(302) 298-0700
jshaw@shawkeller.com
arussell@shawkeller.com
Attorneys for Plaintiff National Steel Car Limited

OF COUNSEL:
Safet Metjahic
Robert D. Keeler
ICE MILLER LLP
1500 Broadway, Suite 2900
New York, NY 10036
(212) 824-4940

Kenneth Sheehan
ICE MILLER LLP
200 Massachusetts Ave NW, Suite 400
Washington, DC 20001
(202) 824-8666

Dated: April 15, 2025

RULE 7.1.1 CERTIFICATION

I hereby certify that on April 11, 2025, the parties conferred verbally by teleconference, with Delaware counsel present, in a good faith and reasonable effort to narrow or resolve the issues raised herein and FreightCar agreed not to oppose this motion.

/s/ Andrew E. Russell
John W. Shaw (No. 3362)
Andrew E. Russell (No. 5382)
SHAW KELLER LLP
I.M. Pei Building
1105 North Market Street, 12th Floor
Wilmington, DE 19801
(302) 298-0700
jshaw@shawkeller.com
arussell@shawkeller.com
Attorneys for Plaintiff National Steel Car Limited

CERTIFICATE OF SERVICE

I hereby certify that on April 16 2025, this document was served on the persons listed below in the manner indicated:

BY EMAIL

John C. Phillips, Jr.
David A. Bilson
PHILLIPS, MCLAUGHLIN & HALL, P.A.
1200 N. Broom St
Wilmington, DE 19806
302-655-4200
jcp@pmhdelaw.com
dab@pgmhlaw.com

Brian C. Horne
KNOBBE, MARTENS, OSLON & BEAR, LLP
1925 Century Park East Suite 400
Los Angeles, CA 90067
brian.horne@knobbe.com

Justin J. Gillett
Sean M. Murray
KNOBBE, MARTENS, OSLON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
949-760-0404
justin.gillett@knobbe.com
sean.murray@knobbe.com

/s/ Andrew E. Russell
John W. Shaw (No. 3362)
Andrew E. Russell (No. 5382)
SHAW KELLER LLP
I.M. Pei Building
1105 North Market Street, 12th Floor
Wilmington, DE 19801
(302) 298-0700
jshaw@shawkeller.com
arussell@shawkeller.com
Attorneys for Plaintiff National Steel Car Limited

EXHIBIT A

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

NATIONAL STEEL CAR LIMITED, Plaintiff, v. FREIGHTCAR AMERICA, INC., Defendant.	))))))))))	C.A. No. 24-594-JLH-CJB **LETTERS ROGATORY: REQUEST FOR INTERNATIONAL JUDICIAL ASSISTANCE PURSUANT TO THE CANADA EVIDENCE ACT, R.S.C., 1985, C. C-5 AND THE QUÉBEC *CODE OF CIVIL PROCEDURE,* CHAPTER C-25.01, S. 504-506**

TO THE QUÉBEC SUPERIOR COURT AND THE MINISTER OF JUSTICE:

The United States District Court for the District of Delaware presents its compliments to the Québec Superior Court and respectfully requests international judicial assistance to obtain evidence to be used in the above-captioned civil action proceeding before this Court. This Court has determined, upon careful consideration of the Plaintiff's Motion for Issuance of Letters Rogatory to Obtain Evidence and representations (the "Plaintiff's Motion"), that it would further the interests of justice if by the proper and usual process of your Court, you summon Canadian National Railway Company to appear before a person empowered under Canadian law to administer oaths and take testimony forthwith, to give testimony under oath or affirmation by questions and answers upon oral examination in respect of the matters and issues identified in Exhibit A1, and permit the parties to create a written transcript and video recording of such testimony. This Court has also determined, upon careful consideration of the Plaintiff's Motion, that it would further the interests of justice if by the proper and usual process of your Court, you summon Canadian National Railway Company to produce copies of the documents in their possession, custody, or control that are identified in Exhibit A2. The evidence sought is relevant to the claims and defenses relating to willful infringement and induced infringement of U.S. Patent Nos. 8,132,515 and 8,166,892 in the

American action. Canadian National Railway Company is likely to have relevant evidence to the extent that they conducted a bidding process for and ultimately accepted delivery of the products accused of infringement in the American action.

The applicant for this letter is National Steel Car Limited, of Hamilton, Ontario. Counsel is available to answer any questions the Québec Superior Court may have. This request is made pursuant to Rule 4(f)(2)(B) of the Federal Rules of Civil Procedure; the All Writs Act, 28 U.S.C. §1651 and 28 U.S.C. §1781 (permitting the transmittal of letters rogatory through the district courts and the Department of State); the *Québec Code of Civil Procedure*, chapter C-25.01, s. 504-506; and the Canada Evidence Act, R.S.C., 1985, c. C-5.

The United States District Court for the District of Delaware is a competent court of law and equity which properly has jurisdiction over this proceeding, and has the power to compel the attendance of witnesses and production of documents both within and outside its jurisdiction. Canadian National Railway Company is a corporation organized in Canada, within the Province of Québec. On information and belief, Canadian National Railway Company has or is likely to have possession of the documents specified in Exhibit A2 and knowledge of the subject matter specified in Exhibit A1 herein. The testimony and production of documents are intended for use at trial or directly in the preparation of trial, and in the view of this Court, will be relevant to claims and defenses in the case. Specifically, the Plaintiff's requests are narrowly targeted to seek testimony and documents from Canadian National Railway Company relating to the bidding process by which it purchased the products accused of infringement that is anticipated to have bearing on the Plaintiff's causes of action for willful patent infringement and induced infringement and the Defendants' defenses and counterclaim regarding the same. This request is made with the understanding that it will in no way require any person to commit any offense, or to undergo a broader form of inquiry than he or she would if the litigation were conducted in a Canadian court.

The requesting Court is satisfied that the evidence sought to be obtained through this request is relevant and necessary and cannot reasonably be obtained by other methods. Because this Court lacks authority to compel participation of these persons and, such participation being necessary in order that justice be served in the above-captioned proceedings, this Court respectfully requests assistance from the Québec Superior Court.

The requesting Court appreciates that some of the documents in Exhibit A2, and the testimony sought in Exhibit A1, may call for confidential, or trade secret information. This Court has issued a Protective Order (D.I. 42) that governs this case and extends to the document productions or testimony of third parties including Canadian National Railway Company. A copy of the governing protective order is attached as Exhibit A3.

Canadian National Railway Company is a Québec entity and, upon information and belief, is not domiciled in the United States. Thus, this Court cannot directly compel Canadian National Railway Company to provide the requested testimony.

It is, therefore, respectfully requested that the Québec Superior Court compel Canadian National Railway Company to produce documents responsive to the requests for production in Exhibit A2 to this Letters Rogatory, to the extent that they are in their possession, custody, or control, and are not privileged under the applicable laws of Canada or the United States. This Court also requests that the Superior Court of Québec compel the appearance of Canadian National Railway Company to testify under oath, concerning the topics set forth in Exhibit A1 to this Letters Rogatory. The requested documents and testimony are needed for use at trial in connection with the parties' claims and defenses. While this Court expresses no view at this time as to the merits in the above-captioned case, it believes the evidence sought here will be relevant to and either probative or disapprobative of material facts relevant to the parties' claims and defenses.

1.	Sender	The Honorable Christopher J. Burke United States District Court for the District of Delaware J. Caleb Boggs Federal Building, 844 N. King Street, Unit 28, Room 2325, Wilmington, DE 19801-3555
2.	Canadian Authority	Québec Superior Court, district of Montréal Palais de justice de Montréal 1, Notre-Dame East St Montréal (Québec) H2Y 1B6
3.	Person to whom the executed request is to be returned	This Court; representatives of the parties as indicated below; the witnesses from whom evidence is requested as indicated below; and such other person(s) that you deem proper.
4.	Specification of the date by which the requesting authority requires receipt of the response to the Letter of Request	Date: June 15, 2025 Reason for Urgency: U.S. litigation is proceeding quickly
5.	a. Requesting Judicial Authority	The Honorable Christopher J. Burke United States District Court for the District of Delaware J. Caleb Boggs Federal Building, 844 N. King Street, Unit 28, Room 2325, Wilmington, DE 19801-3555
	b. To the competent Authority of	Québec Superior Court, district of Montréal
	c. Names of the case and any identifying number	*National Steel Car Ltd. v. FreightCar America, Inc.*, Case No. 24-00594-JLH-CJB (D. Del.)
6.	Names and addresses of the parties and their representative (including representatives in the requested State)	
	a. Plaintiff	There is one Plaintiff: National Steel Car Limited, 600 Kenilworth Ave N, Hamilton, ON L8N 3J4, Canada
	Representatives	John W. Shaw and Andrew E. Russell, Shaw Keller LLP, 1105 North Market Street, 12th Floor, Wilmington, DE 19801; SKNationalSteelCar@shawkeller.com Safet Metjahic, Robert D. Keeler, and Ken Sheehan, Ice Miller LLP, 1500 Broadway, Suite 2900, New York, NY 10036; IM-NSClit@icemiller.com

b. Defendants	There are four Defendants: FreightCar America, Inc., 125 S. Wacker Drive, Suite 1500, Chicago, IL USA 60606; FreightCar North America, LLC, 125 S. Wacker Drive, Suite 1500, Chicago, IL USA 60606; JAC Operations, Inc., 125 S. Wacker Drive, Suite 1500, Chicago, IL USA 60606; and FCA-FASEMEX, LLC, 125 S. Wacker Drive, Suite 1500, Chicago, IL USA 60606.
Representatives	John C. Phillips, Jr. and David A. Bilson, Phillips Mclaughlin & Hall, P.A., 1200 North Broom Street, Wilmington, DE 19806-4204; jcp@phmdelaw.com; dab@pmhdelaw.com. Brian Horne, Sean M. Murray, and Justin J. Gillet, Knobbe, Martens, Olson & Bear LLP, 1925 Century Park East, Suite 400, Los Angeles CA 90067; litfcal.0011@knobbe.com.
c. Other parties	N/A
Representatives	N/A

7.	a. Nature of the proceedings (divorce, paternity, breach of contract, product liability, etc.)	Civil action alleging patent infringement, proceedings have commenced.
	b. Summary of complaint	Plaintiff brought a complaint against the Defendants for patent infringement, including claims of willful infringement and induced infringement, based on U.S. Patent Nos. 8,132,515 and 8,166,892, both entitled "Railroad gondola car structure and mechanism therefor."
	c. Summary of defense and counterclaim	Defendants assert affirmative defenses and counterclaims, including for non-infringement and invalidity of the asserted patents.
	d. Other necessary information or documents	N/A

8. a. Evidence to be obtained or other judicial act to be performed	The testimony and documents identified in Exhibit A1 and Exhibit A2 are necessary to determine facts relevant to the Plaintiff's claims of willful infringement and induced infringement related to U.S. Patent Nos. 8,132,515 and 8,166,892. For this reason, it is respectfully requested that the Québec Superior Court compel (a) representative(s) of Canadian National Railway Company, with personal knowledge of the identified topics and documents to testify at a deposition on the topics listed in Exhibit A1, and (b) the production of documents by Canadian National Railway Company to the Plaintiff requested in Exhibit A2. Attached as Exhibit A2 is a request of production of certain documents that Plaintiff believes are likely to be in the possession, custody, or control of Canadian National Railway Company and/or its subsidiaries.

b. Purpose of the evidence or judicial act sought	With respect to U.S. Patent Nos. 8,132,515 and 8,166,892 and the inventions claimed therein, it is believed that documents and communications between Canadian National Railway Company and Defendants and/or other third-parties exist and are probative to the question as to whether Defendants willfully infringe or infringed upon the asserted patents, or induced others to infringe upon the asserted patents. The evidence is related to Plaintiff's claim of willful infringement and induced infringement. These letters have been issued based on the following criteria: a) The discovery requested is relevant; b) The evidence sought by the letters rogatory is necessary for trial and intended to be adduced at trial, if admissible. This required evidence is relevant to the American proceeding in that it is anticipated to have bearing on the Plaintiff's claims for patent infringement and the Defendants' defenses and counterclaims; c) The discovery requested does not violate the laws of civil procedure of the province of Québec, particularly as they concern third parties; d) The Québec Superior Court may properly authorize the witness(es) to provide the responsive evidence, if any, pursuant to the *Québec Code of Civil Procedure*, CQLR c. C-25.01; e) The evidence sought relates to the abovementioned matter that is pending before this requesting Court of competent jurisdiction; f) The evidence sought cannot otherwise be obtained. This requesting Court has considered the Plaintiff's Motion and has found that the evidence requested is well within the scope of the discovery sanctioned by the United States Federal Rules of Civil Procedure and would be permitted in this action. In the proper exercise of its authority, this requesting Court has therefore determined that the testimony and documents described in Exhibits A1 and A2 cannot be secured except by intervention by the Québec Superior Court. Accordingly, this requesting Court has granted the Plaintiff's Motion and now issues these letters.
9. Identity and address of any person to be examined	One or more corporate representatives of Canadian National Railway Company, 935 de La Gauchetière Street West, Montreal, Québec, Canada, H3B 2M9.

10. Questions to be put to the persons to be examined or statement of the subject matter about which they are to be examined	*See* Exhibit A1
11. Documents or other property to be inspected	*See* Exhibit A2
12. Any requirement that the evidence be given on oath or affirmation and any special form to be used	It would further the interests of justice if, by the proper and usual process of your Court, you summon representative(s) of Canadian National Railway Company, with personal knowledge of the identified topics and documents, to appear before a person empowered under Québec law to administer oaths and take testimony and give testimony under oath or affirmation on the topics listed in Exhibits A1 by questions and answers upon oral examination, either at a convenient location in Montréal, Québec, or by way of such technological means (such as videoconference) as may be accepted by your Court.
13. Special methods or procedure to be followed (e.g. oral or in writing, verbatim, transcript or summary, cross-examination, etc.)	This Court respectfully requests that Canadian National Railway Company be directed to produce the documents identified in attached Exhibit A2. We respectfully request that the court direct the witness to appear on or before June 15, 2025. We respectfully request that the witness be directed to answer such questions as Plaintiff or their counsel desire, relating to matters outlined in attached Exhibit A1. We respectfully request that the examination be permitted to be conducted in accordance with the Federal Rules of Evidence, and the United States Federal Rules of Civil Procedure, except to the extent such procedure is incompatible with the laws of Québec and the laws of Canada applicable therein. Specifically, objections during the examination will be later ruled on by the District of Delaware, except for those questions Québec regulations and laws do not require to be answered at the time of the deposition. We respectfully request that the testimony be recorded. We respectfully request that the testimony be taken in English language if the examined person(s) agree, and that, if need be, simultaneous translation be provided. Costs incurred for complying with the Federal Rules of Evidence (court reporter, video recorder, simultaneous translation) shall be at Plaintiff's expense. The requesting Court further requests that the witness(es) be examined for no more than seven (7) hours of testimony. This Court also requests that the above-mentioned U.S. counsel for the Plaintiff and Defendants, and Canadian counsel retained by the parties, be permitted to participate in the examinations, by attending the testimony of the witnesses either in person or by videolink and be permitted to examine and cross-examine the witness(es).

14. Request for notification of the time and place for the execution of the Request and identity and address of any person to be notified	This Court respectfully requests that you notify this Court; the representatives of the parties as indicated above; the witness from whom evidence is requested as indicated above; and such other person(s) that your Court deems proper.
15. Request for attendance or participation of judicial personnel of the requesting authority at the execution of the Letter of Request	No judicial personnel of the requesting authority will attend or participate.
16. Specification of privilege or duty to refuse to give evidence under the law of the State of origin	Under the laws of the United States, a witness has a privilege to refuse to give evidence if to do so would disclose a confidential communication between the witness and his or her attorney that was communicated specifically for the purpose of obtaining legal advice and which privilege has not been waived. Certain limited immunities are also recognized outside the strict definition of privilege, such as the limited protection of work product created by attorneys during or in anticipation of litigation. Plaintiff believes that Canadian National Railway Company does not benefit from any privilege or immunities in this case.
17. Reciprocity	The requesting Court expresses its sincere willingness to provide similar assistance and to honor similar appropriate requests from the Québec Superior Court if future circumstances should require.
18. The fees and costs incurred which are reimbursable under will be borne by:	Plaintiff will pay the witness(es)'s costs that are reimbursable under applicable under Québec law. Plaintiff will provide the court reporter and pay the witness(es)'s appearance fee as required by Québec law.

So ORDERED and SIGNED this _____day of _____, 2025.[1]

_____
Christopher J. Burke,
United States Magistrate Judge

[1] Neither party shall use any statement in this order in connection with a future substantive, evidentiary, or discovery dispute in this case, except insofar as it relates to effectuating these Letters Rogatory.

EXHIBIT A1

EXHIBIT A1

Topics for the Deposition of Canadian National Railway Company

DEFINITIONS

1. "Canadian National," "CN," "You" and "Your" means Canadian National Railway Company, its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. Canadian National Railway Company is a Québec company having a principal place of business at 935 de La Gauchetière Street West Montreal, Québec, Canada H3B 2M9.

2. "DMIR" means the Duluth, Missabe, and Iron Range Railway.

3. "Plaintiff" or "NSC" refers to National Steel Car Limited, the Plaintiff in the Action, its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. National Steel Car Limited is an Ontario corporation having a principal place of business at 600 Kenilworth Ave N, P.O. Box 2450, Hamilton, ON L8N 3J4, Canada.

4. "Defendants" or "FreightCar" refers to FreightCar America, Inc., a Defendant in the Action, its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. FreightCar America, Inc. is a Delaware Corporation having an address at 125 South Wacker Drive, Chicago, IL 60606.

5. "Greenbrier" refers to The Greenbrier Companies, Inc., its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. The Greenbrier Companies Inc. is an Oregon corporation having an address at One Centerpointe Drive, Suite 200 Lake Oswego, Oregon 97035.

6. "ARI" refers to American Railcar Industries, Inc., its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. American Railcar Industries, Inc. was a North Dakota corporation having an address at 100 Clark Street, St. Charles, Missouri 63301. Successor companies include Greenbrier, ITE Management L.P., and American Industrial Transport (AITX).

7. "TrinityRail" refers to Trinity Industries, Inc., its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. Trinity Industries, Inc. is a Delaware Corporation having an address at 14221 N. Dallas Parkway, Suite 1100, Dallas, TX 75254.

8. "Rail Car Competitors" include at least Greenbrier, ARI, and TrinityRail, or any other manufacturer of rail cars that supplied Jennies to You or submitted bids or considered submitting bids for Jennies to You.

9. "Jennies" refer to open-top bottom-discharge hopper rail cars for use on the DMIR.

10. "Action" refers to *National Steel Car Limited v. FreightCar America, Inc.*, *et al*, No. 24-594-JLH-CJB (D. Del.).

11. The "'892 Patent" refers to U.S. Patent No. 8,166,892 entitled "Railroad Gondola Car Structure and Mechanism Therefor," issued on May 1, 2012, a copy of which is attached hereto as Exhibit A1-1.

12. The "'515 Patent" refers to U.S. Patent No. 8,132,515 entitled "Railroad Gondola Car Structure and Mechanism Therefor," issued on March 13, 2012, a copy of which is attached hereto as Exhibit A1-2.

13. The "Asserted Patents" refers to the '892 Patent and the '515 Patent.

14. "Related Patents" include any patent or application, whether in the U.S. or Canada, that is a parent, continuation, or divisional of, or otherwise related to, any Asserted Patent.

15. "Relate" or "Relating to" means consisting of, referring to, reflecting, concerning, or being in any way logically or factually connected with the matter discussed.

16. "Communication" means the transmission of information or data in any form, including, without limitation, written, oral, visual, or electronic transmissions.

17. "Including" means including, but not limited to.

18. The terms "and" and "or" should be construed either conjunctively or disjunctively as necessary to bring within the scope of the request all responses that might otherwise fall outside the scope of this request.

19. The terms "all," "any," or "each" encompass any and all of the matter discussed.

20. The use of singular form includes plural and vice versa.

21. The use of present tense includes past tense and vice versa.

DEPOSITION TOPICS

1. Jennies proposed, constructed, sold, or offered to You by NSC, including the technical details thereof.

2. Jennies proposed, constructed, sold, or offered to You by FreightCar, including the technical details thereof.

3. Jennies proposed, constructed, sold, or offered to You by any Rail Car Competitor, including the technical details thereof.

4. Requirements for or desired features of Jennies provided by You to NSC, FreightCar, or Rail Car Competitors between 2007 and 2024 and Communications relating to the same.

5. Bids to supply Jennies to You by NSC, FreightCar, or Rail Car Competitors between 2007 and 2024 and Communications relating to the same.

6. The bidding process for Jennies between 2007 and 2024.

7. The Asserted Patents and the inventions claimed therein, including Your knowledge and analysis thereof and Communications relating to the same by or to any of You, FreightCar, and/or any Rail Car Competitor.

8. Any Related Patents, including Your knowledge and analysis thereof and Communications relating to the same by or to any of You, FreightCar, and/or any Rail Car Competitor.

9. Communications by or to any of You, NSC, FreightCar and/or any other Rail Car Competitor relating to the Asserted Patents or any claim or invention described therein.

10. Communications by or to any of You, FreightCar, and/or any Rail Car Competitor relating to NSC Jennies and/or the technical details or specifications thereof.

11. Communications by or to any of You, FreightCar, and/or any Rail Car Competitor relating to any bid or proposal by NSC to supply Jennies to You.

12. Inspections of NSC Jennies by FreightCar and/or any other Rail Car Competitor.

13. Your rationale for the decision to purchase NSC Jennies in or around 2009, including the features or advantages of the NSC Jennies and/or bid that led to that decision.

14. Your rationale for the decision to purchase ARI Jennies, including any features or advantages of the ARI Jennies and/or bid that led to that decision.

15. Your decision to purchase FreightCar Jennies in or around 2023 and the features or advantages of the FreightCar Jennies and/or bid that led to that decision.

16. Maintenance of Jennies, including FreightCar Jennies, ARI Jennies, and NSC Jennies.

17. Your preparation for Your deposition in this action.

18. Contracts for Jennies between 2007 and 2024 and any documents related thereto.

19. Intellectual property licenses related to Jennies or open-top, bottom-discharge railcars.

20. The identity, location, creation, and distribution of documents concerning each of the foregoing topics.

EXHIBIT A1-1

US008166892B2

(12) **United States Patent**
Forbes et al.

(10) **Patent No.: US 8,166,892 B2**
(45) **Date of Patent: May 1, 2012**

(54) **RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR**

(75) Inventors: **James W. Forbes**, Campbellville (CA); **Marcus Thiesen**, Hamilton (CA); **Dave Keats**, Brantford (CA)

(73) Assignee: **National Steel Car Limited** (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 284 days.

(21) Appl. No.: **12/559,065**

(22) Filed: **Sep. 14, 2009**

(65) **Prior Publication Data**

US 2011/0041724 A1 Feb. 24, 2011

(30) **Foreign Application Priority Data**

Sep. 11, 2009 (CA) 2678447
Sep. 14, 2009 (CA) 2678605

(51) **Int. Cl.**
B61D 17/00 (2006.01)

(52) **U.S. Cl.** **105/406.1**; 105/396; 105/404

(58) **Field of Classification Search** ..... 105/199.4, 105/406.1, 413, 414, 415, 420, 247, 244, 105/250, 254, 396, 404; 213/50, 51, 56, 213/60, 61, 75 R

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

673,103 A * 4/1901 Williamson 105/248

(Continued)

FOREIGN PATENT DOCUMENTS

CA 1082524 A1 7/2009

(Continued)

OTHER PUBLICATIONS

Freight Cars: Hopper, Ore; Car Builders' Cyclopedia, 1937, pp. 313-320, 14th ed., Simmons-Boardman Publishing Corporation, New York, NY.

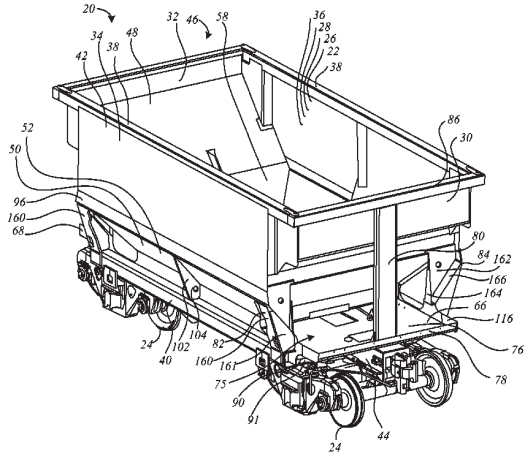
(Continued)

Primary Examiner — S. Joseph Morano
Assistant Examiner — Jason C Smith
(74) *Attorney, Agent, or Firm* — Hahn Loeser & Parks, LLP; Michael H. Minns

(57) **ABSTRACT**

A railroad gondola car has a hopper carried between two trucks. The hopper has convergent end and side slope sheets that feed a bottom discharge. The bottom discharge has a pair of longitudinal doors. The door closing mechanism is a mechanical transmission that includes a set of linkages running from the door to a reciprocating pneumatic cylinder. The linkages run generally parallel to the slope sheet. The car has a very short draft installation that includes a removable coupler carrier bar, and the main shear plate has a removable draft gear installation panel. There is a machinery space above the end section shear plate. It is overhung by the slope sheet that is substantially unobstructed by any other primary structure. The pneumatic cylinder is mounted on an angle in this unobstructed machinery space, oriented longitudinally over the draft sill beneath the main drag link of the mechanical transmission, and above the main pivot of the driving input lever of the transmission. The main lever is bifurcated, and straddles the pneumatic cylinder. The mechanism includes a primary lock in the form of an over center lever arrangement, and a compact secondary lock that acts sideways rather than lengthwise. The sidewalls of the car include vertical stiffeners and side sheets. The lower portion of the side sheets lies laterally inboard of the stiffener web, while the upper portion lies laterally outboard of the stiffener web. The side slope sheet of the hopper meets the sidewall at the transition of the sidewall sheet from the inside-the-post to the outside-the-post condition.

15 Claims, 18 Drawing Sheets



U.S. PATENT DOCUMENTS

763,186	A		6/1904	Johnson	
1,421,439	A		7/1922	Finckh	
3,173,381	A		3/1965	Charles et al.	
3,187,684	A		6/1965	Ortner	
3,405,655	A	*	10/1968	Dorey	105/250
3,408,956	A		11/1968	Rebenok et al.	
3,483,830	A		12/1969	McGrath	
3,577,932	A		5/1971	Pulcrano et al.	
3,596,609	A		8/1971	Ortner	
3,611,947	A		10/1971	Nagy	
3,654,873	A		4/1972	Floehr	
3,710,730	A	*	1/1973	Austgen et al.	105/250
3,717,109	A		2/1973	Miller	
3,717,110	A		2/1973	Miller	
3,800,711	A		4/1974	Tuttle	
3,807,316	A		4/1974	Miller	
3,815,514	A		6/1974	Heap	
3,818,842	A		6/1974	Heap	
3,863,986	A		2/1975	Mentessi	
3,872,796	A		3/1975	Adler et al.	
3,878,794	A		4/1975	Adler	
3,931,768	A		1/1976	Price et al.	
3,949,681	A		4/1976	Miller	
3,994,238	A		11/1976	Adler	
4,106,813	A		8/1978	Goodbary	
4,120,409	A		10/1978	vander Werff	
4,194,450	A		3/1980	Miller	
4,222,334	A		9/1980	Peterson	
4,224,877	A	*	9/1980	Stark et al.	105/250
4,232,989	A	*	11/1980	Miller	414/387
4,246,849	A	*	1/1981	Gramse	105/251
4,250,814	A		2/1981	Stark et al.	
4,252,068	A		2/1981	Nolan	
4,348,962	A	*	9/1982	Smith	105/248
4,361,097	A	*	11/1982	Jones et al.	105/406.1
4,484,527	A	*	11/1984	O'Hara	105/247
4,542,701	A		9/1985	Fischer et al.	
4,555,033	A		11/1985	Miller	
RE32,189	E	*	6/1986	Adler et al.	105/377.07
4,601,244	A		7/1986	Fischer	
4,637,320	A	*	1/1987	Paton et al.	105/406.1
4,740,130	A		4/1988	Prins	
4,800,820	A	*	1/1989	Tomaka	105/406.1
4,843,974	A		7/1989	Ritter et al.	
4,884,511	A		12/1989	Hallam et al.	
4,893,568	A	*	1/1990	Adams	105/416
4,898,101	A	*	2/1990	Harter	105/247
5,063,858	A		11/1991	Dugge	
5,086,709	A		2/1992	Fischer et al.	
5,144,895	A		9/1992	Murray	
5,163,372	A		11/1992	Galvan et al.	
5,181,474	A	*	1/1993	Miller	105/355
5,249,531	A		10/1993	Taylor	
5,261,333	A		11/1993	Miller	
5,813,353	A	*	9/1998	Sauter	105/406.1
5,823,118	A		10/1998	Manstrom	
6,604,469	B1		8/2003	Galvan et al.	
6,745,701	B2		6/2004	Elder	
6,877,440	B1	*	4/2005	Kilian et al.	105/406.1
7,080,598	B2	*	7/2006	Creighton et al.	105/247
7,367,272	B2		5/2008	Taylor	
7,681,507	B2	*	3/2010	Herzog et al.	105/286
7,735,426	B2	*	6/2010	Creighton et al.	105/286
7,780,021	B2		8/2010	Forbes	
7,784,411	B2	*	8/2010	Forbes	105/406.1
2007/0277696	A1	*	12/2007	Forbes	105/406.1
2010/0011987	A1	*	1/2010	Forbes	105/406.1
2010/0219148	A1	*	9/2010	Forbes et al.	213/51
2010/0251922	A1	*	10/2010	Forbes et al.	105/240
2011/0041724	A1	*	2/2011	Forbes et al.	105/240

FOREIGN PATENT DOCUMENTS

CN	101486347		7/2009
EP	0543279	B1	5/1995
EP	1790547	A1	5/2007
EP	1798103	A1	6/2007
GB	1318571		5/1973
GB	2013598		8/1979

OTHER PUBLICATIONS

A.C.F. Covered and Open Top Hopper Cars; Car Builders' Cyclopedia, 1943, pp. 281-289, 16th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1957, pp. 265-272, 20th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1961, pp. 246-258, 21st ed., Simmons-Boardman Publishing Corporation, New York, NY.

Car and Locomotive Cyclopedia, 1966, 10 pages, 1st ed., Simmons-Boardman Publishing Corporation, New York, NY.

5 Photographs of Quebec Iron and Titanium (QIT) ore hopper car No. 556, dated Aug. 15, 2007.

Drawing of QIT car dated Aug. 27, 2007.

2 Sheets of Details of End Structure of an Admitted Prior Art Grain Car of National Steel Car showing End Post, Lateral Intermediate Stub Wall, Elephant Ears Arrangement and End Slope Sheet to Shear Plate Connection at least as early as Jan. 1, 2001.

Reproduction of Design Drawing of Dulth, Missabi & Iron Range (DM&IR) Open Topped Ore Hopper Car General Arrangement Drawing 8760 Drawn Apr. 8, 1950, (Quality Poor in Original), Showing Rear Draft Stops Extending Inboard of Truck Center.

* cited by examiner

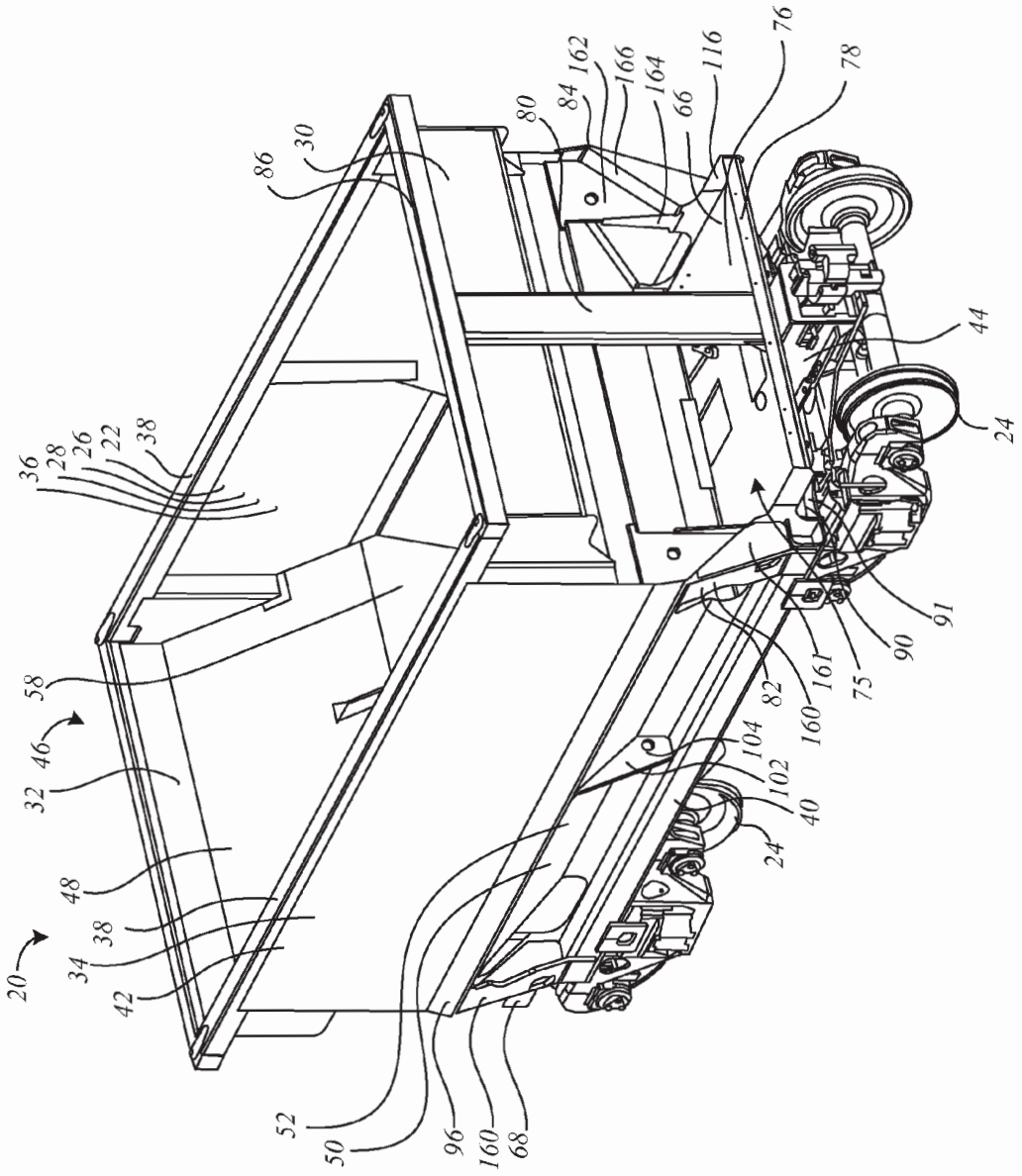

76
78
116
166
164
162
84
80
66
86
30
44
24
36
28
26
22
38
58
46
32
48
38
34
42
20
52
50
96
160
68
91
90
75
161
160
82
104
102
40
24

Figure 1

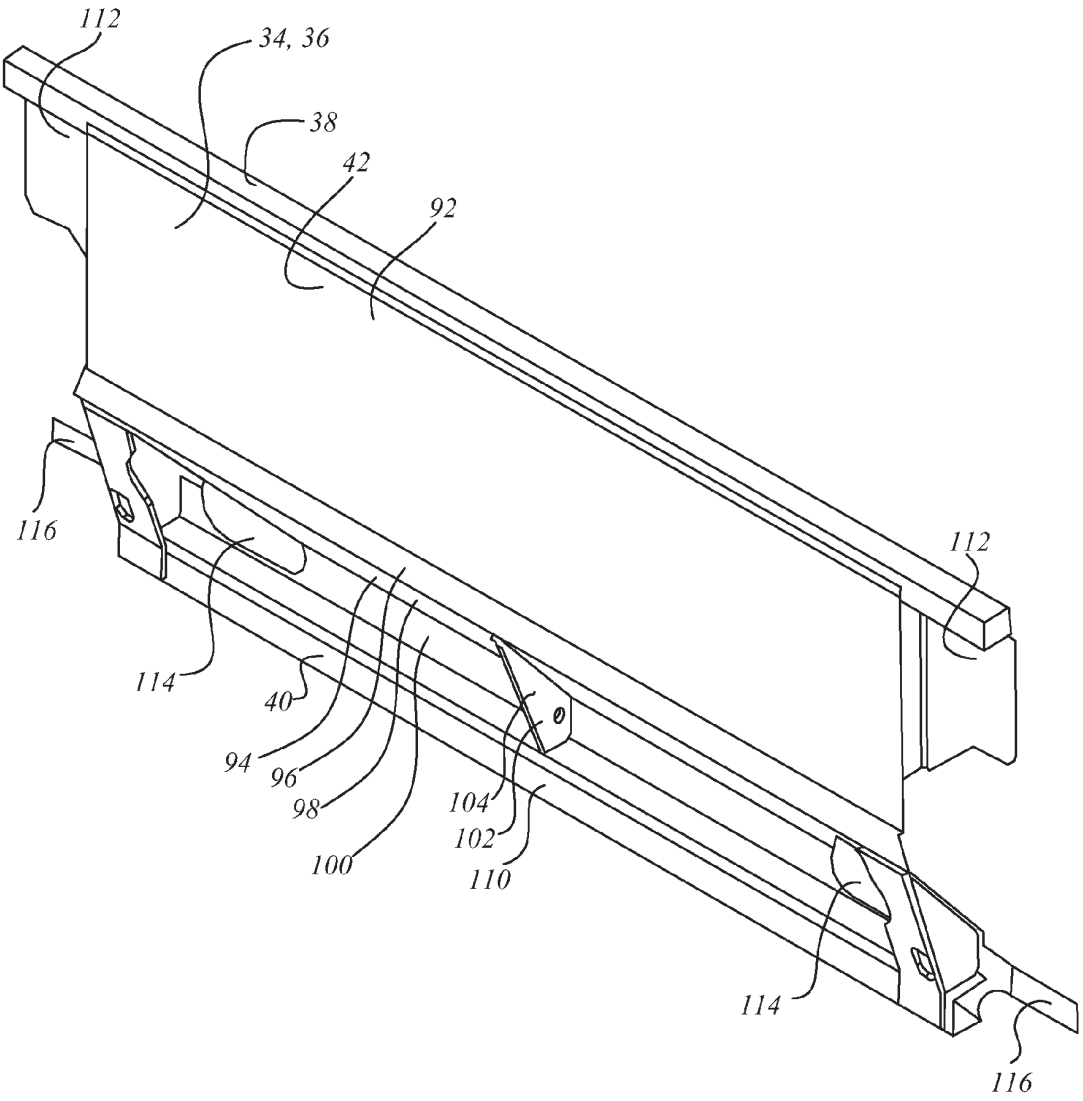


Figure 2a

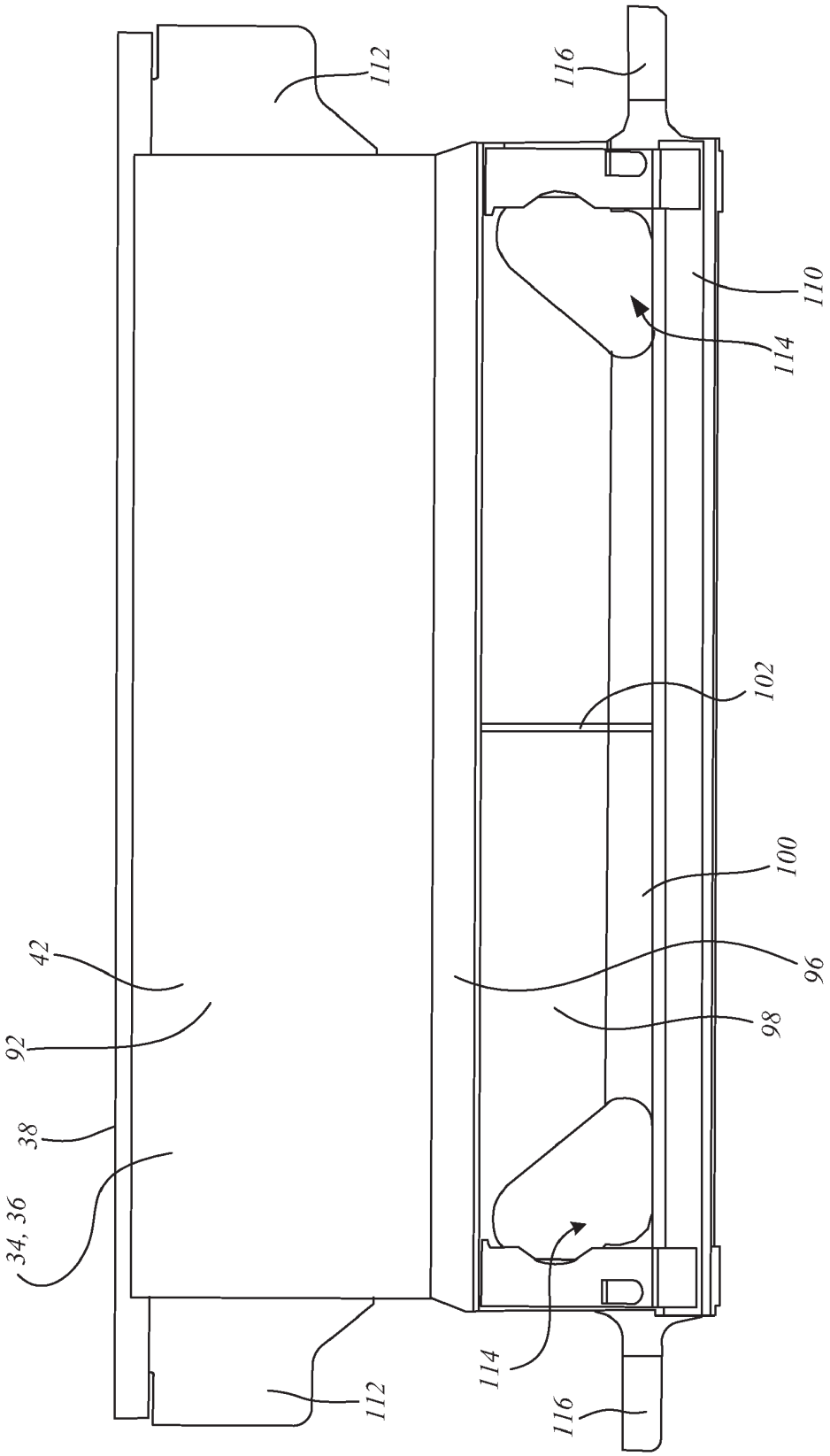


Figure 2b

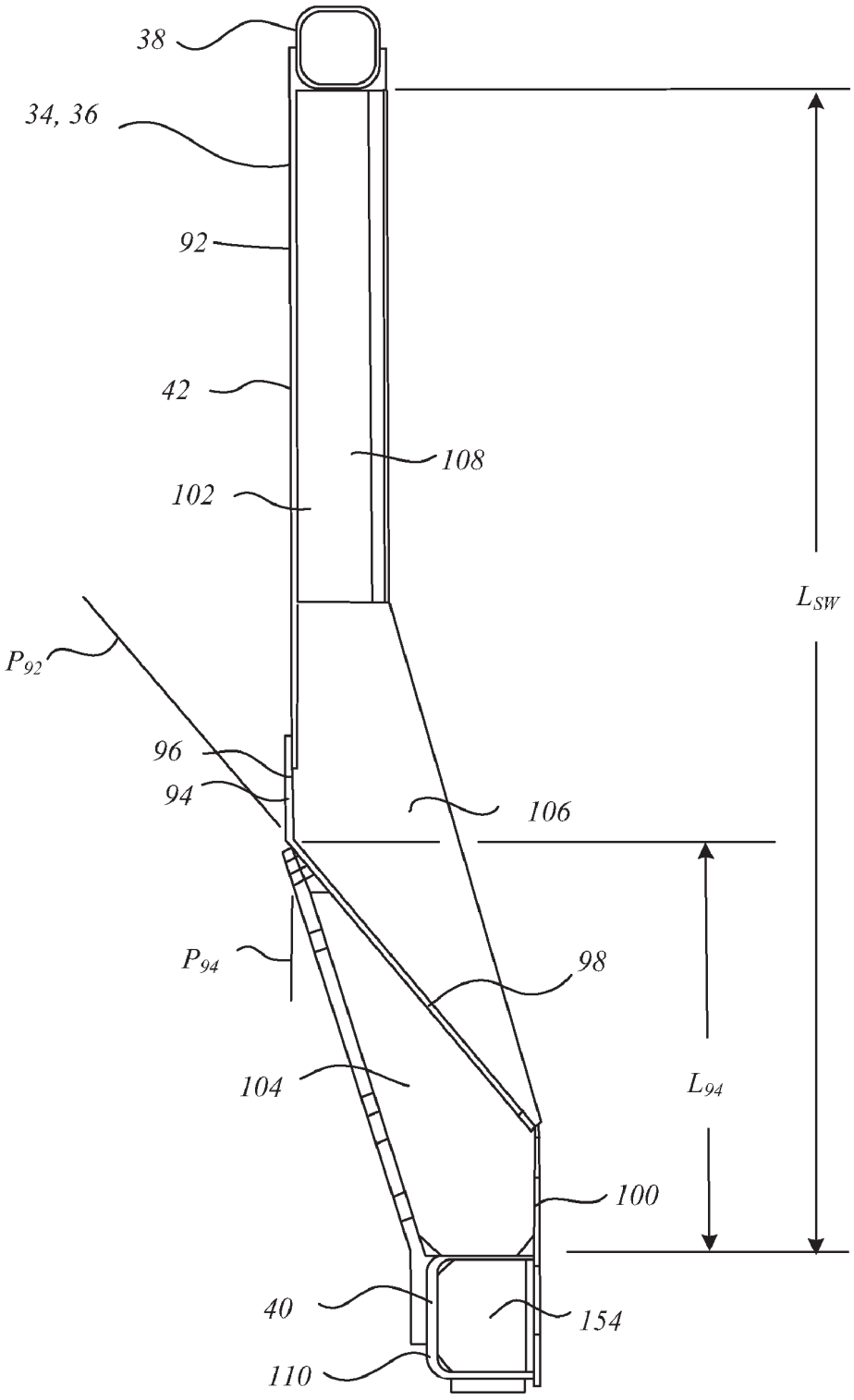

38
34, 36
92
42
108
102
L_{SW}
P_{92}
96
94
106
P_{94}
98
104
L_{94}
100
40
154
110

Figure 2c

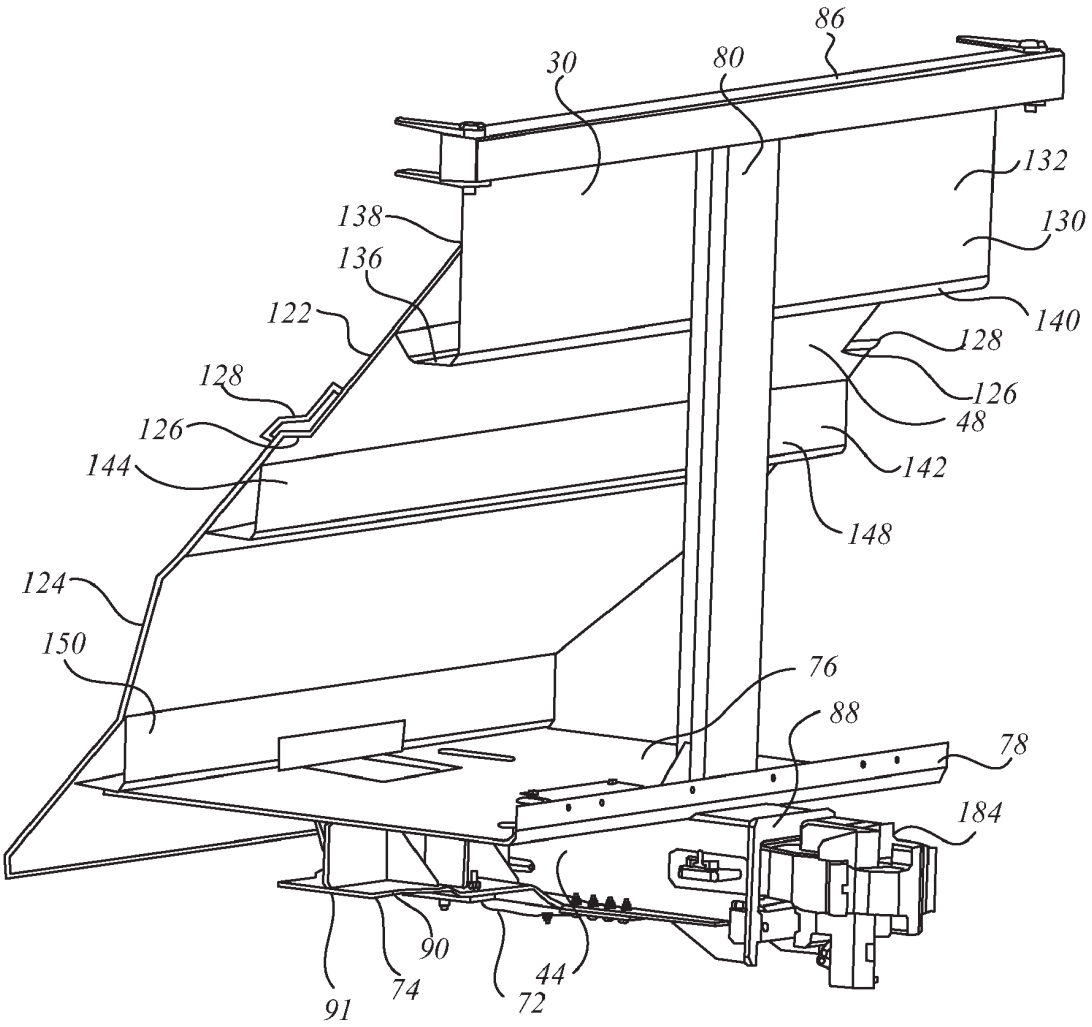

86
30
80
132
138
130
136
122
140
128
128
126
48
126
144
142
148
124
150
76
88
78
184
90
44
91
74
72

Figure 3a

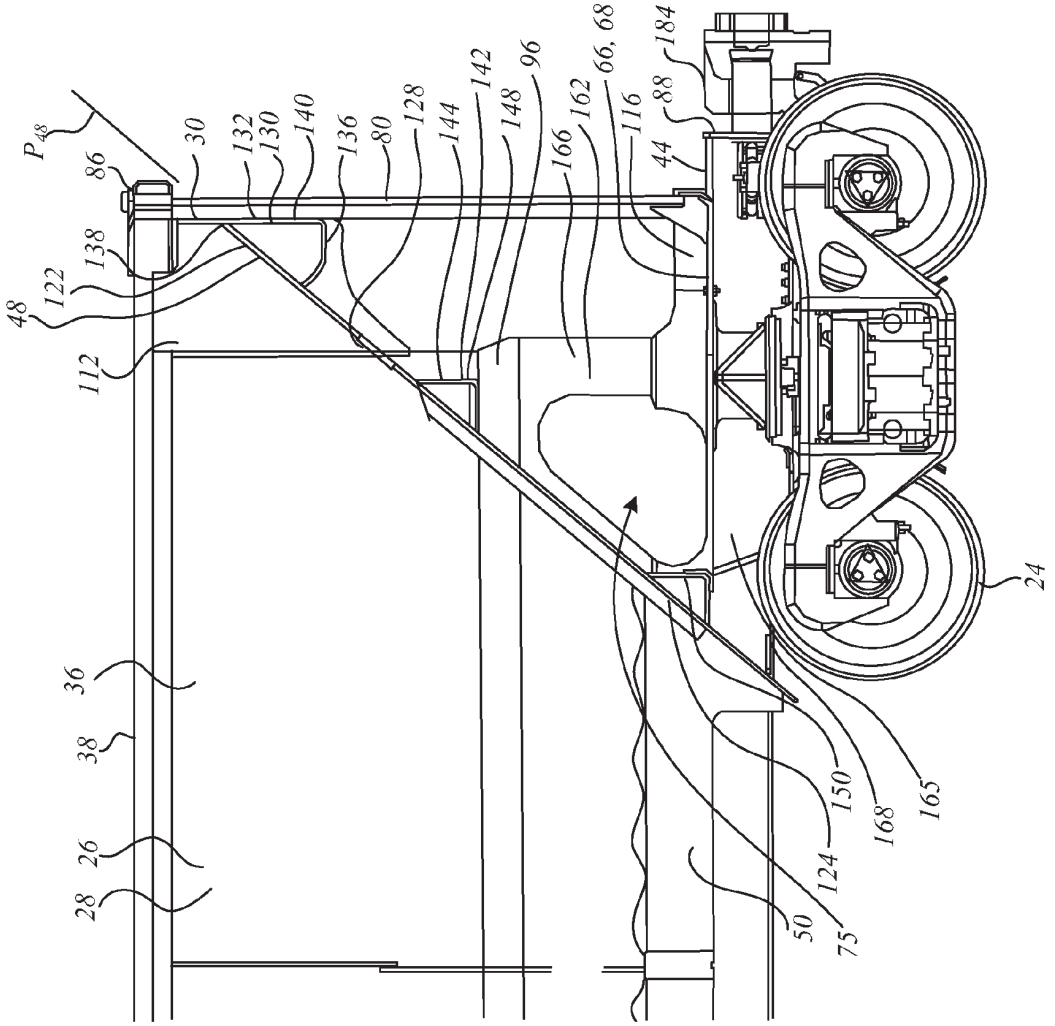

P_{48}
30
132
130
140
136
80
128
144
142
148
96
166
162
66, 68
116
88
184
44
86
138
122
48
112
36
38
26
28
50
124
75
150
168
165
24

Figure 3b

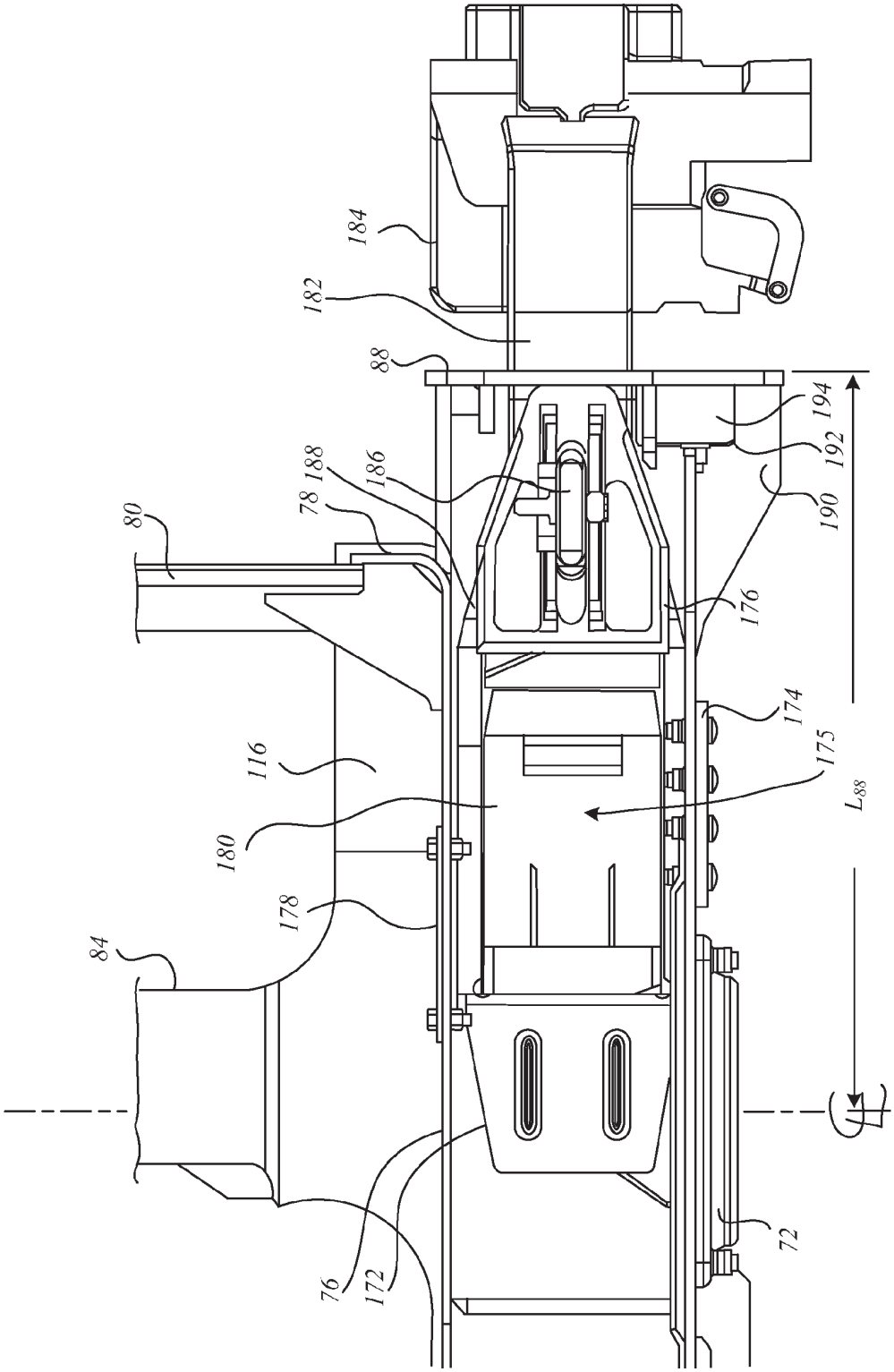

184
182
88
194
192
190
188
186
78
80
176
174
175
116
180
178
84
L_{88}
72
76
172

Figure 3c

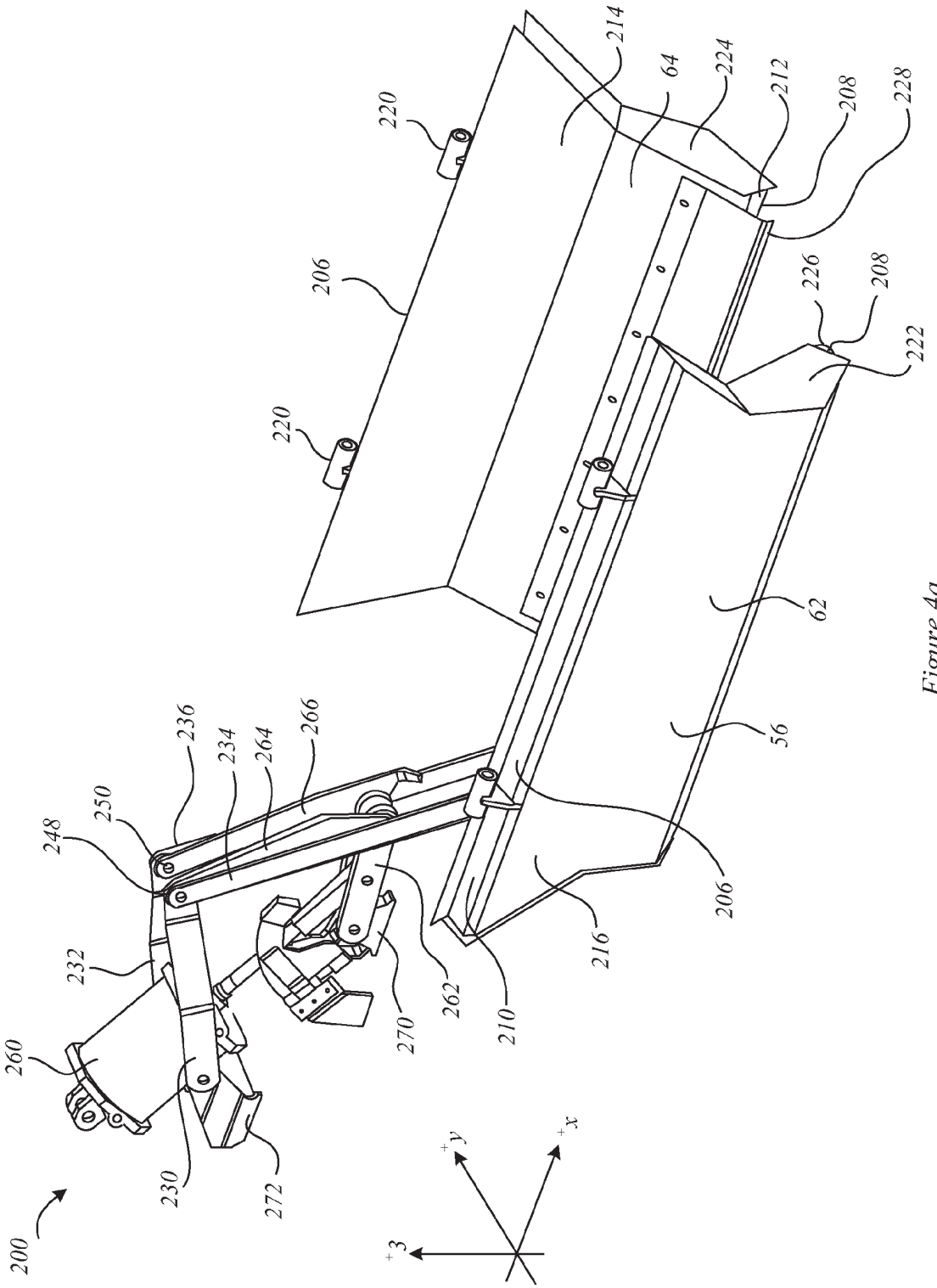

214
64
224
212
208
228
220
206
226
208
222
220
62
56
206
216
210
262
270
272
230
260
232
248
250
236
234
264
266
200
+y
+x
+3

Figure 4a

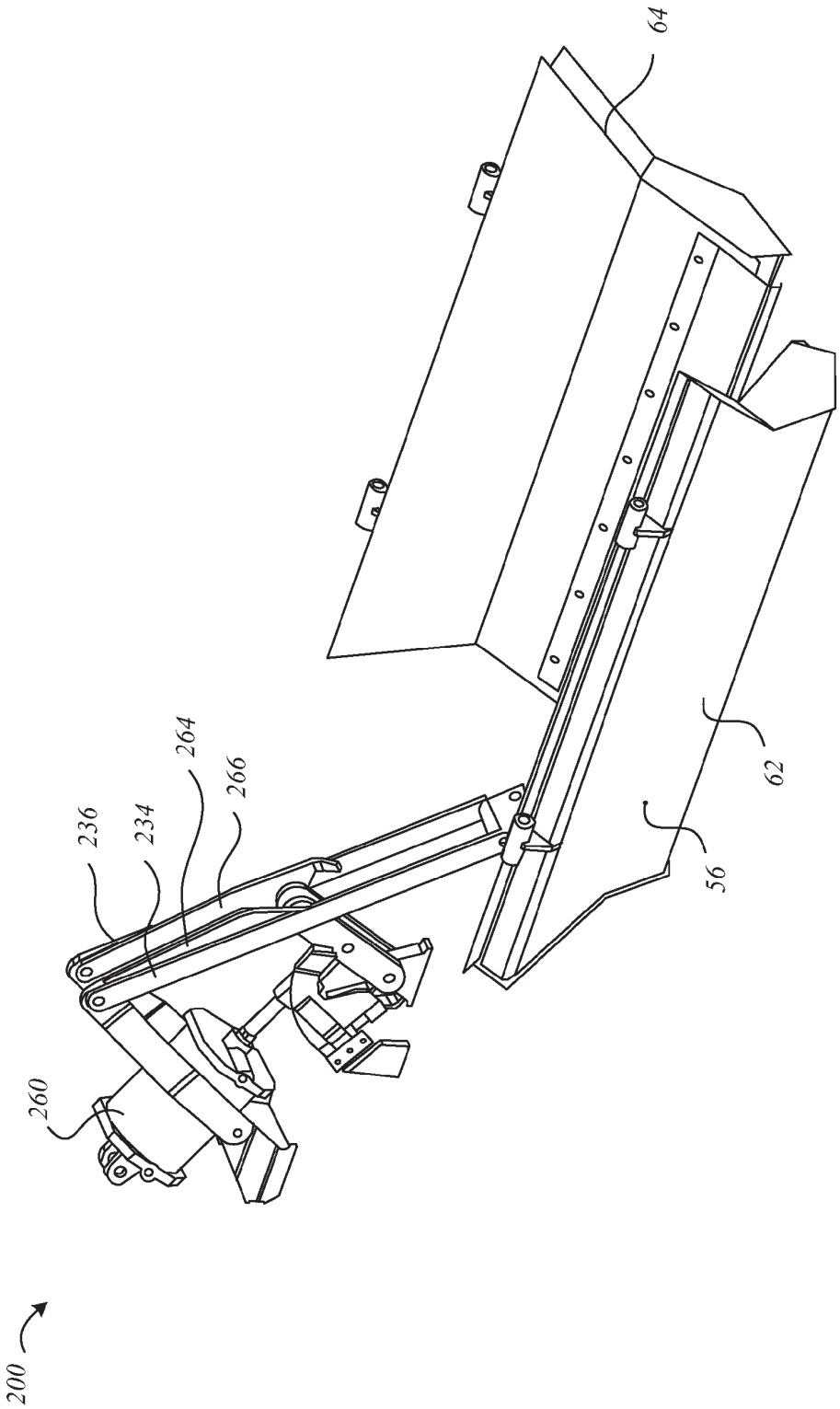


Figure 4b

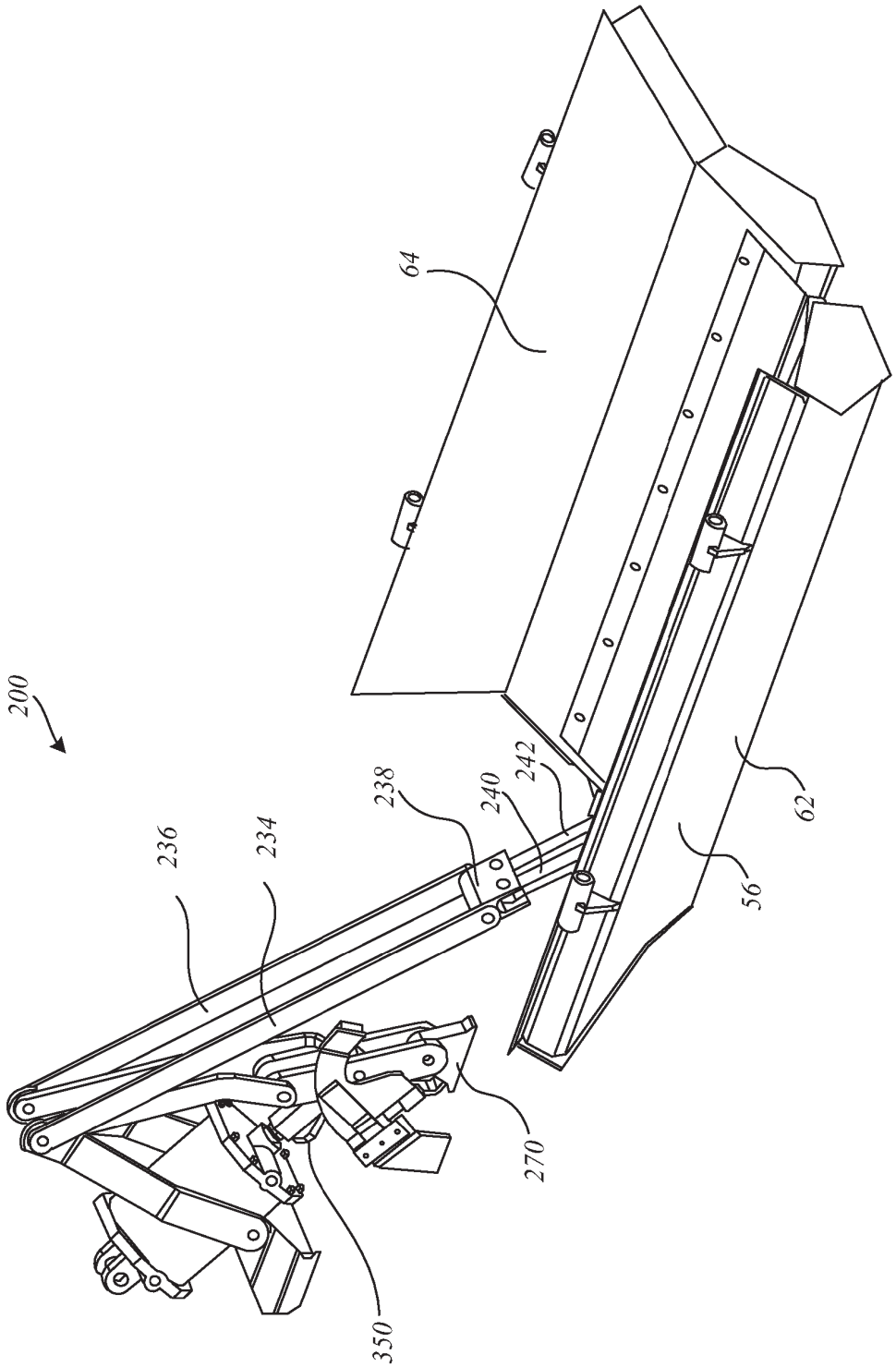


Figure 4c

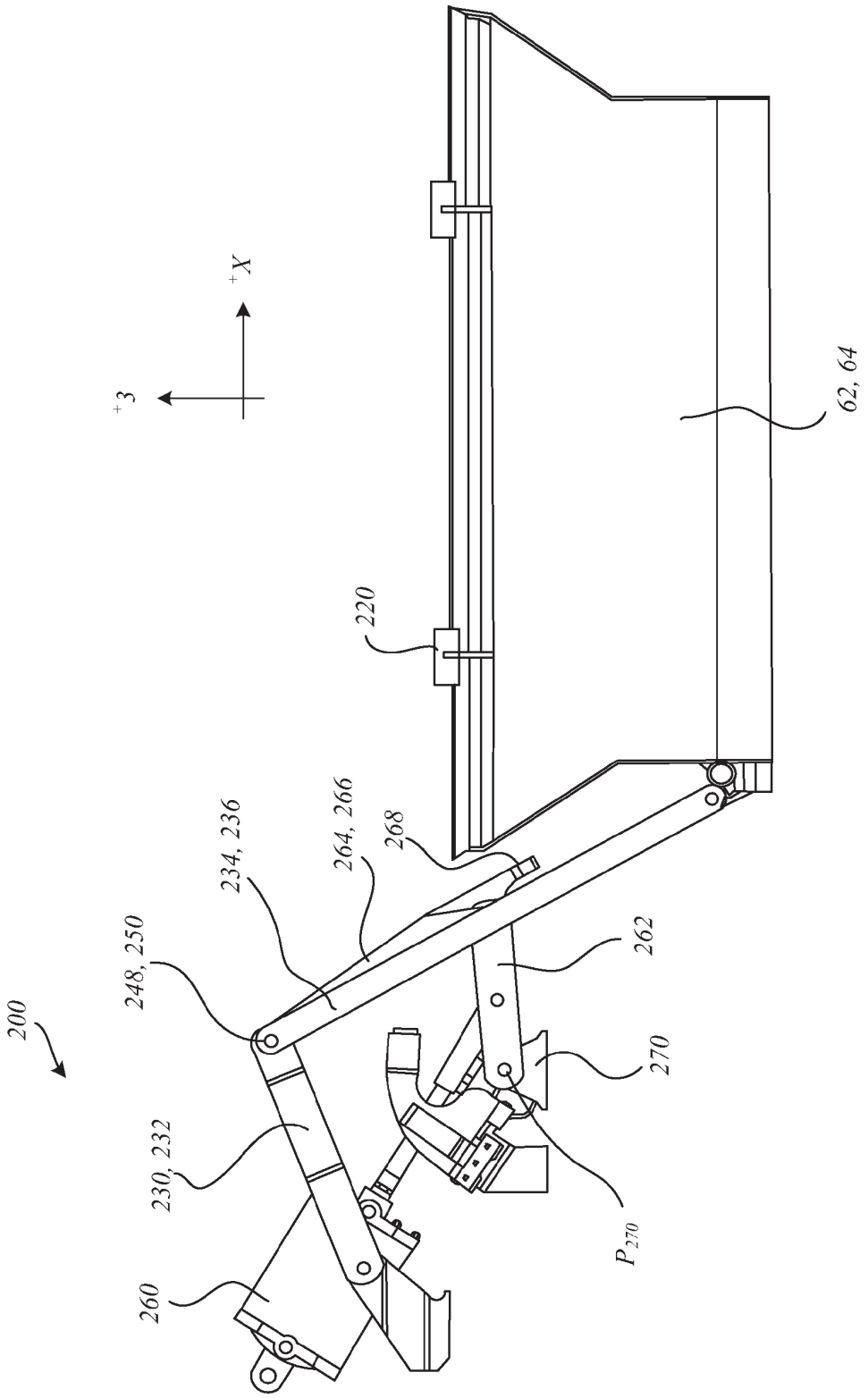

+X
+3
62, 64
220
234, 236
264, 266
268
248, 250
262
200
270
230, 232
P_{270}
260

Figure 5a

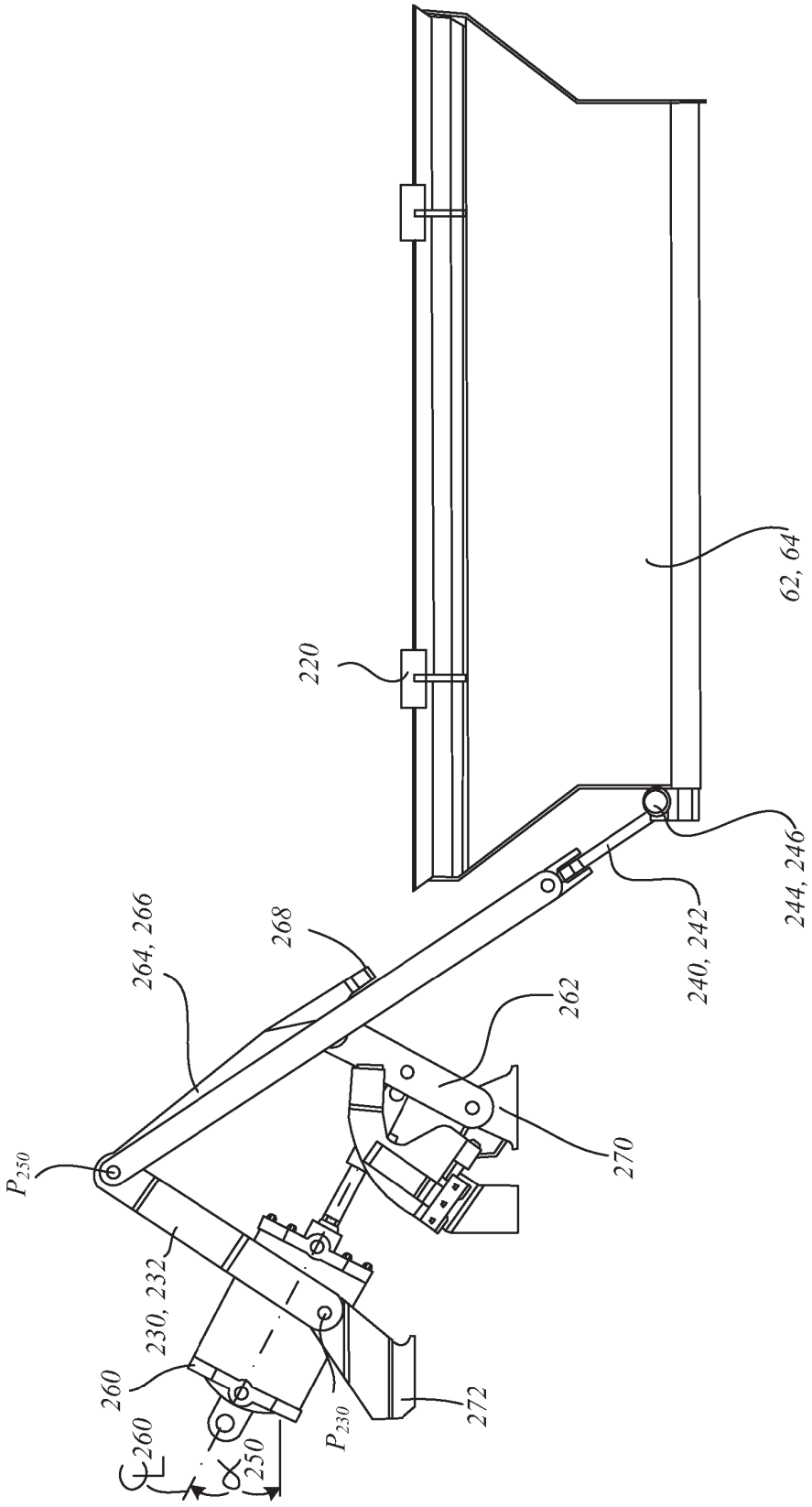

220
62, 64
244, 246
240, 242
268
264, 266
262
270
P_{250}
230, 232
260
260
250
P_{230}
272

Figure 5b

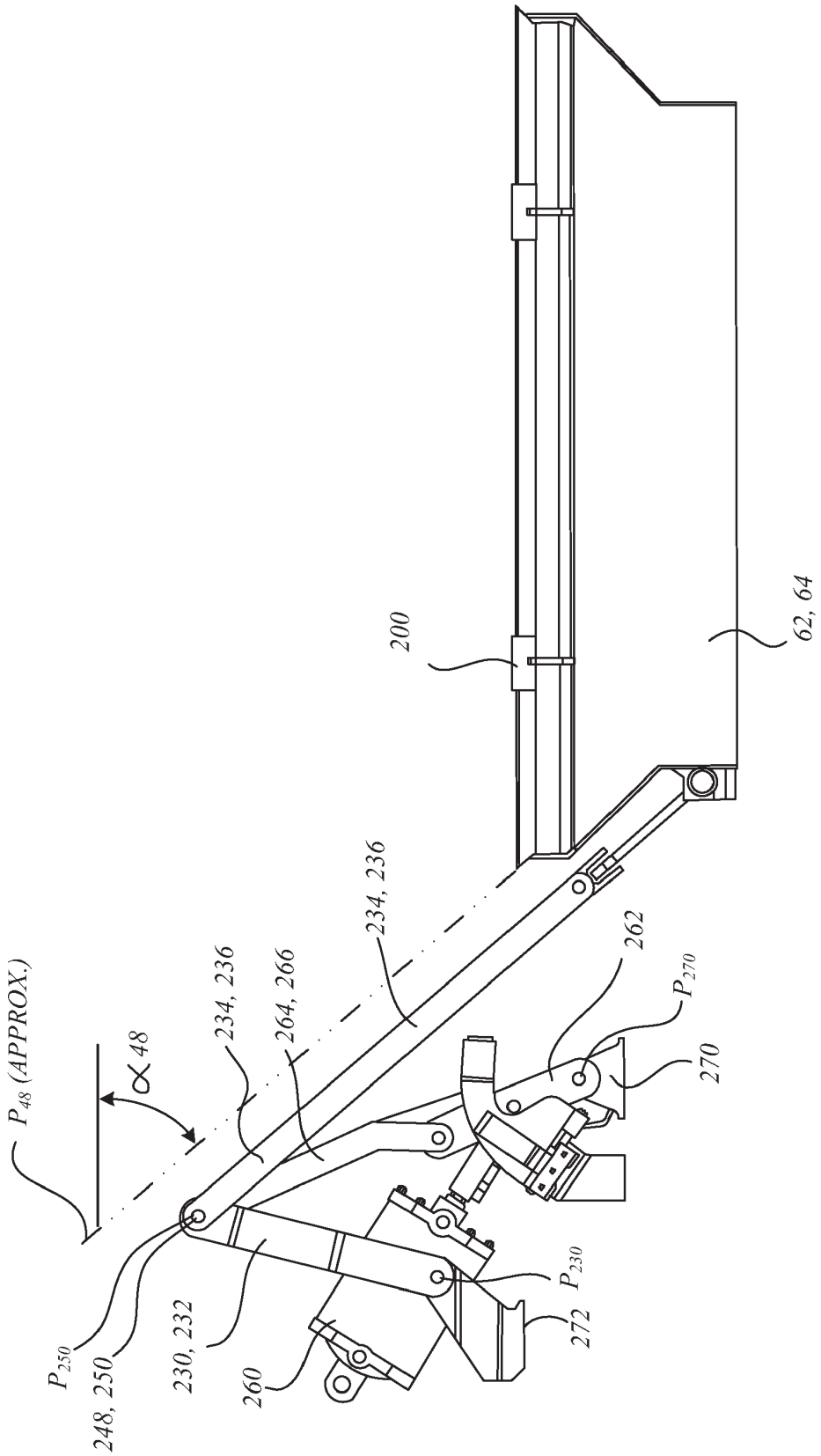

200
62, 64
234, 236
262
P_{270}
270
P_{48} (APPROX.)
48
234, 236
264, 266
P_{230}
272
P_{250}
248, 250
230, 232
260

Figure 5c

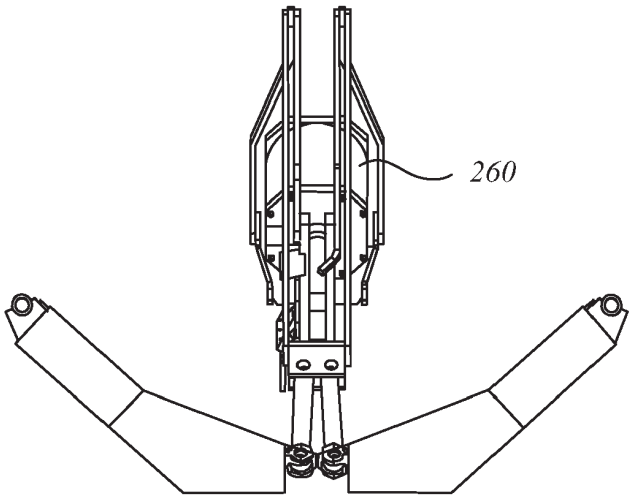


Figure 6c

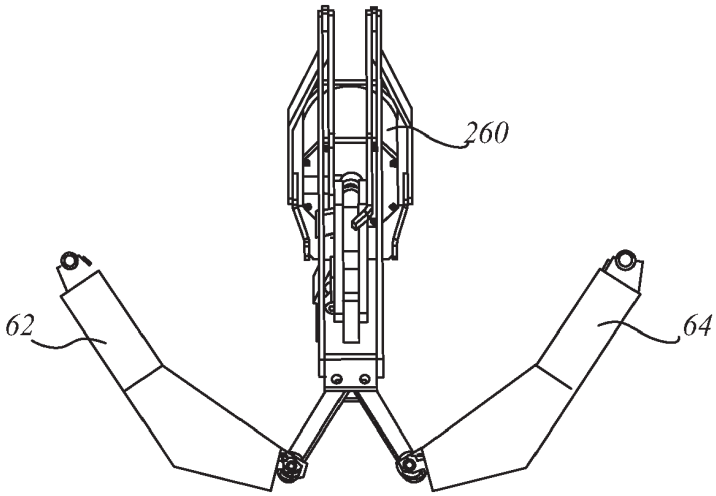


Figure 6b

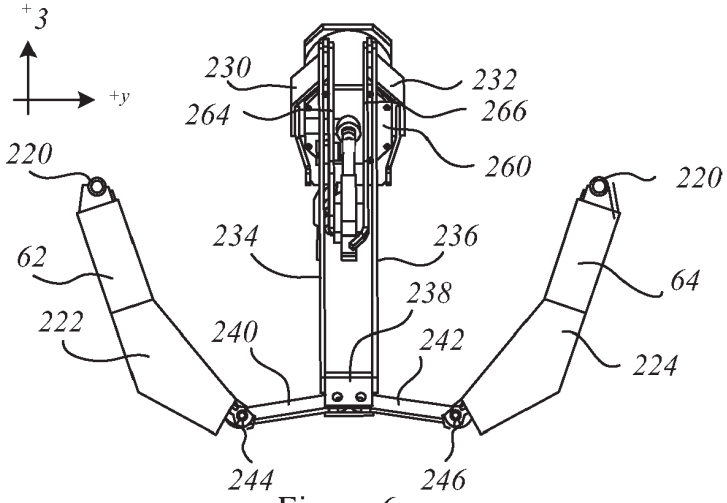


Figure 6a

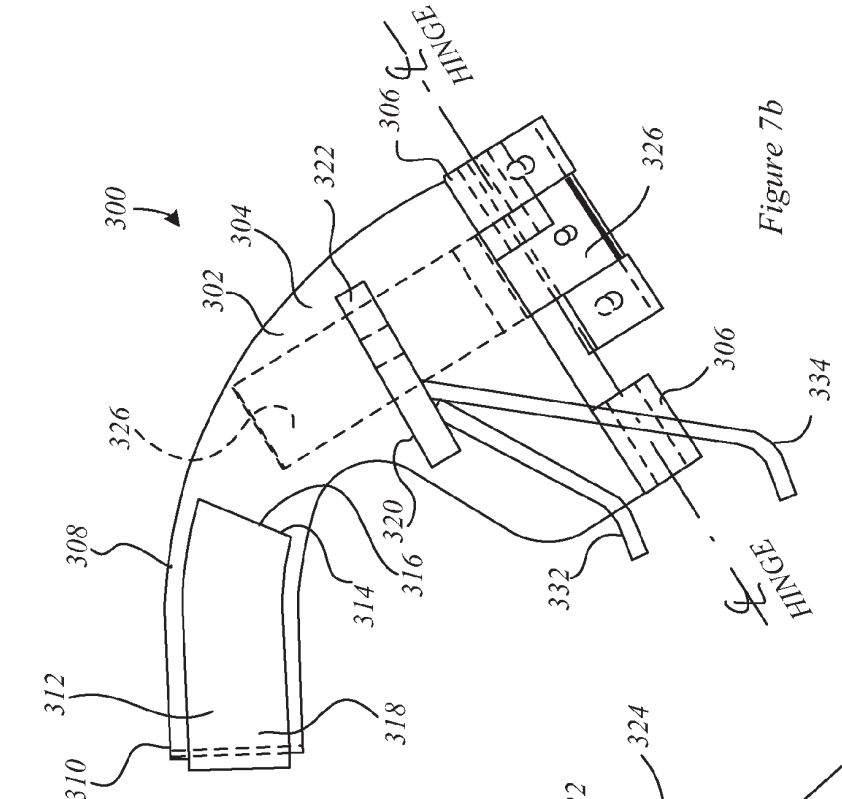


Figure 7b

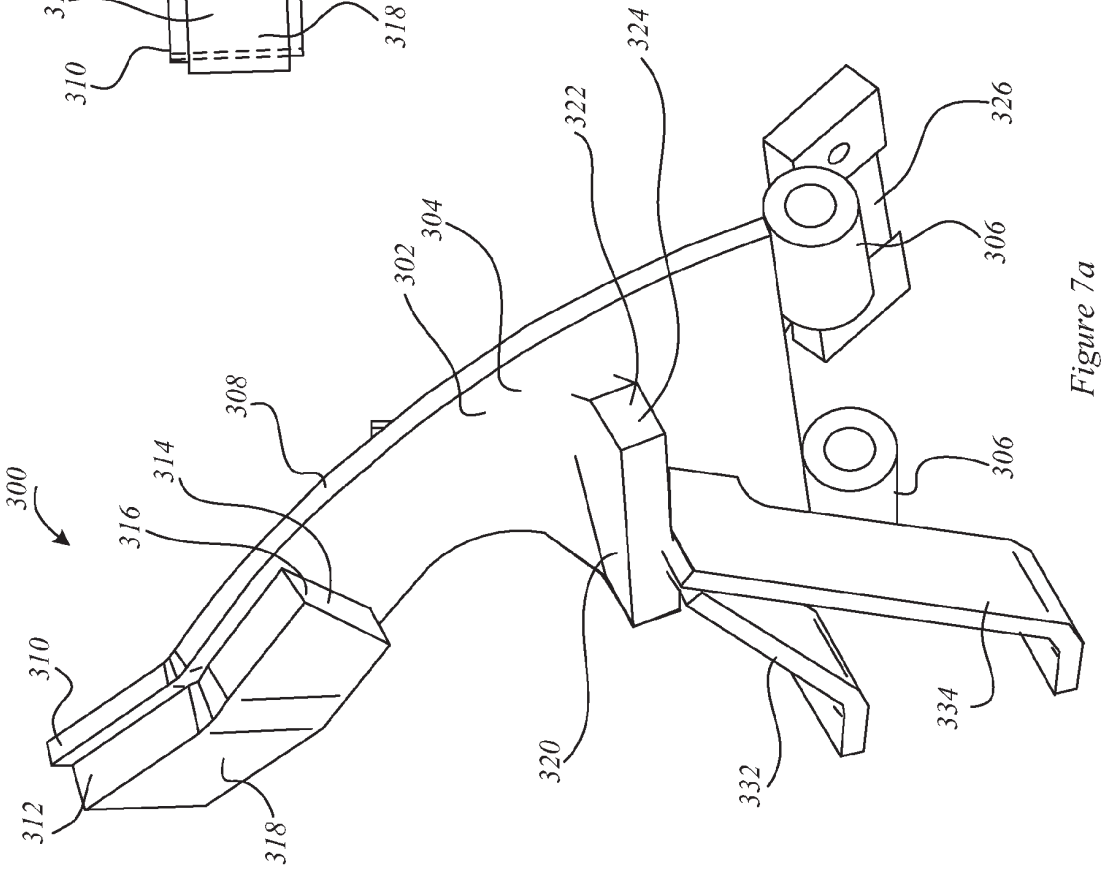


Figure 7a

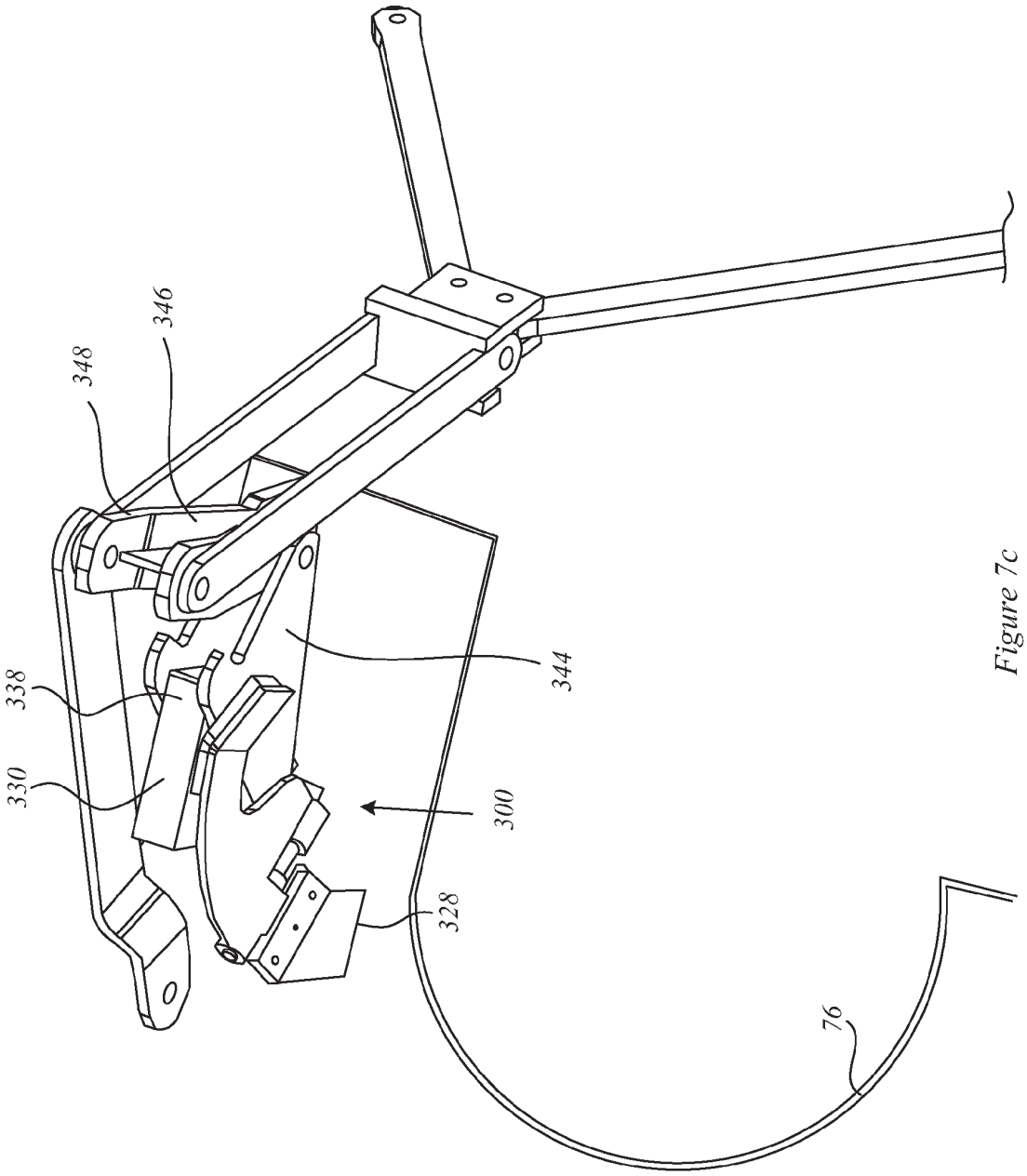


Figure 7c

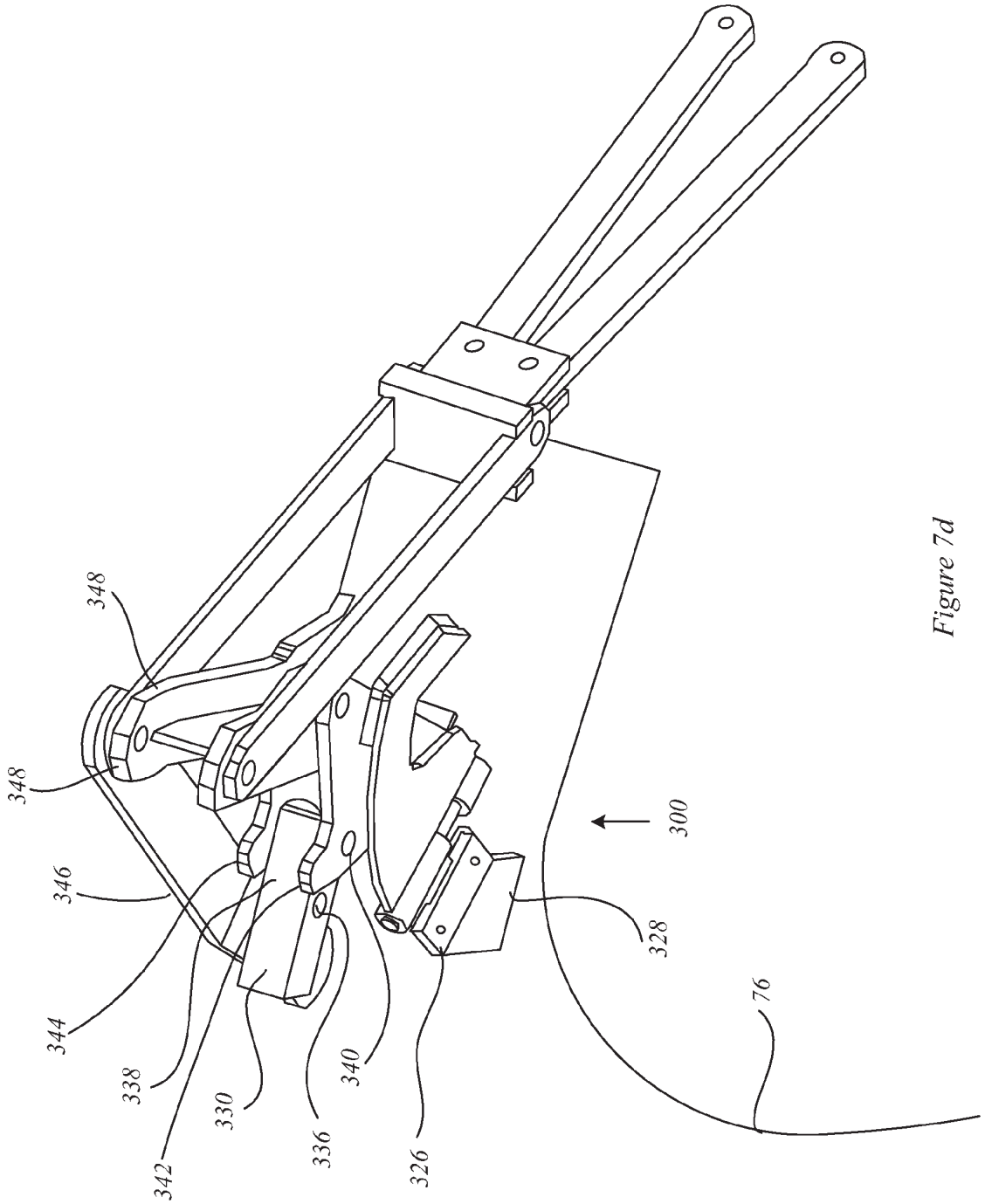


Figure 7d

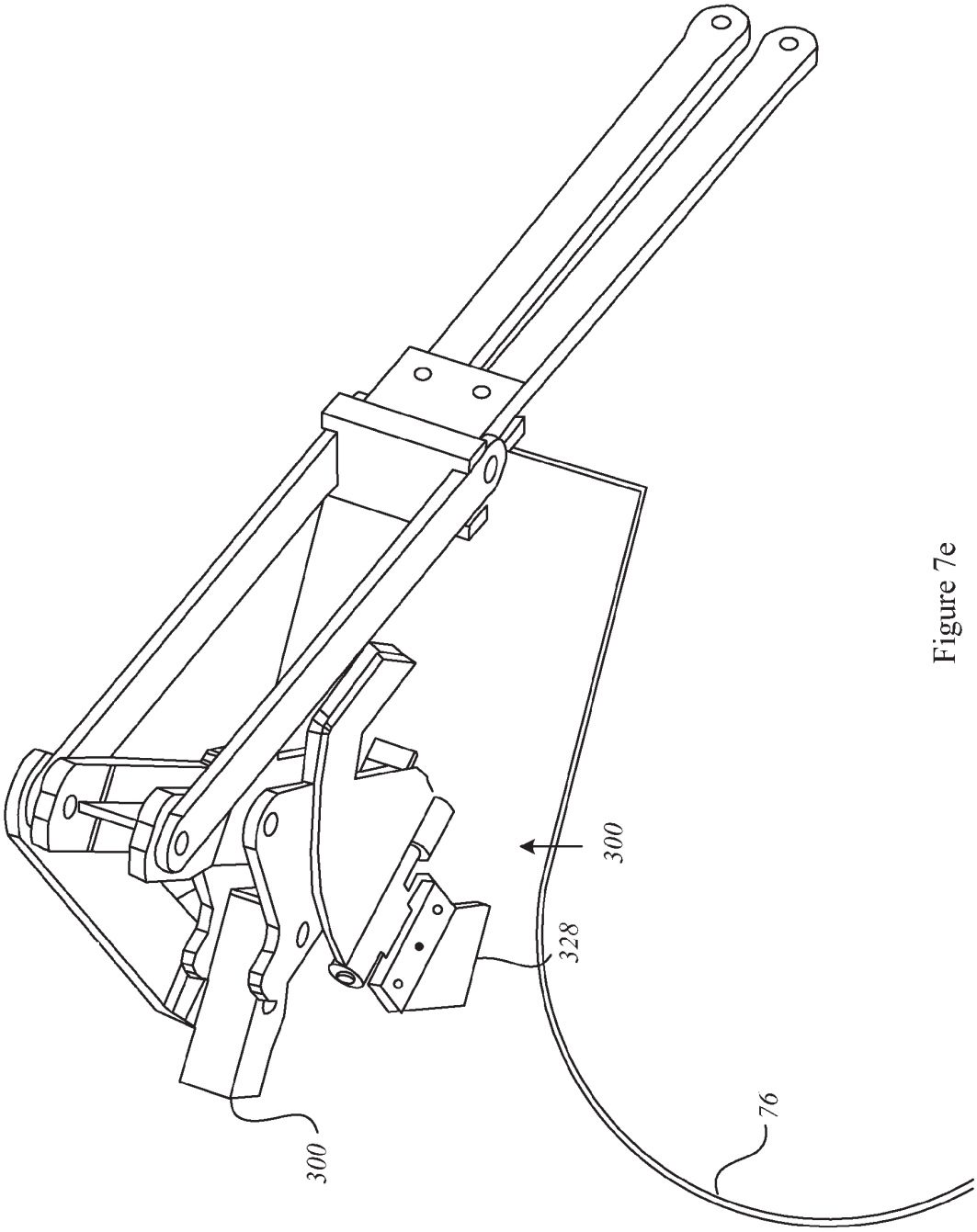


Figure 7e

RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR

This application claims priority under 35 USC 119 on the basis of Canadian Patent Application Serial Number 2,678,447, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 11, 2009, the specification of which is incorporated herein by reference. This application also claims priority to Canadian Patent Application Serial Number 2,678,605.

FIELD OF THE INVENTION

This invention relates to the field of railroad freight cars, and, in particular to rail road gondola cars such as may employ bottom unloading gates or doors.

BACKGROUND

There are many kinds of rail road cars for carrying particulate material, be it sand or gravel aggregate, plastic pellets, grains, ores, potash, coal or other granular materials. Many of those cars have an upper opening, or accessway of some kind, by which the particulate is loaded, and a lower opening, or accessway, or gate, or door by which the particulate material exits the car under the influence of gravity. While the inlet opening need not necessarily have a movable gate, the outlet opening requires a governor of some kind that is movable between a closed position for retaining the lading while the lading is being transported, and an open position for releasing the lading at the destination. The terminology "flow through" or "flow through rail road car" or "center flow" car, or the like, may sometimes be used for cars of this nature where lading, typically particulate lading, is introduced at the top, and flows out at the bottom.

Discharge doors for gondola cars or other bottom dumping cars may tend to have certain desirable properties. First, to the extent possible it is usually desirable for the door opening to be large so that unloading may tend to be relatively fast, and for the sides of any unloading chute to be relatively steep so that the particulate will tend not to hang up on the slope. Further, to the extent that the door can be large and the slope sheets steep, the interior of the car may tend to have a greater lading volume for a given car length. Further still, any increase in lading achieved will tend to be at a relatively low height relative to Top of Rail (TOR) and so may tend to aid in maintaining a low center of gravity. A low center of gravity tends to yield a better riding car that is less prone to derailment, and perhaps less prone to cause as much wear or damage to tracks.

For a given length of car, hopper volume, and hence overall car volume, can be maximized by reducing the proportion of the length of the car occupied by the trucks, and occupied by the door opening drive mechanism. Furthermore, where the lading to be carried by the car is of greater than usual density, it may often be helpful for the truck center length to be relatively short such that the length of the span between the trucks is smaller, and the weight of the structure may be correspondingly decreased relative to the maximum permissible gross weight on rail for the car. In some instances, as with iron ore or other high density lading, that truck center distance may be very short.

It may also be that in some circumstances ore cars are used in quasi-permanent sets that form a unit train. The unit train may tend to follow a single route for substantially its entire operational service life. In the case of an ore car, that operational route may be from a mine or concentrator facility, at

which the cars receive the lading; to a discharge facility, whether a mill or a break of bulk terminal at a port. In these circumstances the line may be owned by the mine or mill, and the cars may not necessarily be used for interchange service. To the extent that they are not used for interchange service they may not necessarily comply with all AAR standards. The cars may have short, possibly non-standard draft sills, draft gear, and couplers, or a combination thereof.

The cars may have tightly limited space envelopes over the end shear plates, and yet these spaces may nonetheless be intended to accommodate, for example, the brake reservoir and pneumatic gear for operating the gondola discharge doors.

SUMMARY OF THE INVENTION

In an aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a door movable between a closed position for retaining lading and an open position for permitting egress of lading. The hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has at least a first end slope sheet inclined downwardly in the lengthwise direction toward the door. There is a linkage connected to the door. The linkage is oriented lengthwise with respect to the car. A drive is connected to the linkage. The drive is operable to move the linkage and thereby to urge the door to a closed position. The linkage is movable from a first position corresponding to the open position of the door to a second position corresponding to the closed position of the door. The linkage includes at least a drag link. When the linkage moves from the first to the second position one of (a) the overall motion from the first to the second position includes displacement of the drag link in a direction having a predominant component of motion parallel to the first end slope sheet; and (b) the motion of the drag link is at least instantaneously parallel to the first end slope sheet.

In another feature of that aspect of the invention the linkage includes a first pivot arm pivotally connected to a datum structure at a first pivot connection. The drive is also mounted to the datum structure. The linkage includes a second pivot arm pivotally connected to the datum structure at a second pivot connection. The second pivot arm has the door mounted thereto. The first pivot arm has a second connection distant from the first pivot connection. The second pivot arm has a second connection distant from the second pivot connection. A mechanical transmission is mounted between the second connection of the second pivot arm and the second connection of the first pivot arm. The mechanical transmission includes the drag link. The drive is connected to move the first pivot arm, and, in moving from the first position to the second position, each position of the first pivot arm being associated with a unique position of the drag link. In a further feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. Each second pivot arm has a respective second con-

nection distant from the respective second pivot connection. A mechanical transmission is mounted between the respective second connections of the second pivot arms and the respective second connections of the first pivot arms. The drag link is a left hand drag link, and the mechanical transmission includes a mated parallel right hand drag link. The left and right hand drag links each have a first end mounted to one of the respective second connections of the first pivot arms. The left and right hand drag links have second ends yoked together distantly from the first ends. The transmission member includes left and right hand slave links extending between and connecting the second ends of the drag links to the second connections of the second pivot arms respectively.

In still another feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. The left and right hand pivot arms co-operate to define a bifurcated lever straddling the drive. In yet another feature, the drive includes an actuating cylinder having an axially reciprocating member, the axially reciprocating member being inclined relative to horizontal. In still another feature the drag link lies between the actuating cylinder and the first end slope sheet of the hopper. In another feature the railroad hopper car includes a first end section, the first end section includes a draft sill and a substantially horizontal shear plate mounted over the draft sill, the drive includes an actuating cylinder having an axis of reciprocation lying in a central vertical-lengthwise plane of the car, the actuating cylinder is mounted above the shear plate, the first end slope sheet at least partially overhangs the actuating cylinder; and the drag link is located between the actuating cylinder and the first slope sheet.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. The car includes structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. A door operating linkage is connected to the gate, the door operating linkage being oriented lengthwise with respect to the car. An actuating cylinder connected to drive the door operating linkage, the actuating cylinder also being oriented to act lengthwise with respect to the car, the actuating cylinder having an axis of reciprocation. The axis of reciprocation being tilted such that displacement of the actuating cylinder includes a vertical component of motion.

In another feature of that aspect of the invention, the hopper car includes an end section mounted over one of the trucks, the end section includes a substantially horizontal shear plate, and the actuating cylinder is mounted on a pedestal mounted to the shear plate, the pedestal including an inclined mounting for the cylinder. In a further feature, the railroad hopper car has a longitudinal-vertical central plane, and the axis or reciprocation lies in the longitudinal-vertical plane. In a still further feature, the hopper includes at least a first end slope sheet extending longitudinally and being inclined longitudinally inboard and downwardly toward the gate, and at least part of the actuating cylinder is overhung by at least part of the first end slope sheet. In a yet further feature, the hopper car includes an end section having a substantially horizontal shear plate mounted over a draft sill. The hopper includes a first end slope sheet, the first end slope sheet at least partially overhanging the horizontal shear plate. The actuating cylinder is mounted above the shear plate, centrally aligned over the draft sill. The actuating cylinder is at least partially overhung by the first end slope sheet. In still yet another further feature the first slope sheet is substantially planar and has a first angle of inclination relative to horizontal. The actuating cylinder is inclined longitudinally inboard downwardly, and is inclined at a second angle. The second angle lies between horizontal and the first angle. In yet another feature the car has an underframe and the door operating linkage includes a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, the first pivot linkage being a first pivot arm constrained to pivot on an axis of rotation oriented horizontally cross-wise relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and includes at least the gate. The third linkage component includes a drag link element connected to the first pivot arm, the drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator. In still another feature the main pivot connection of the first pivot arm to the first linkage component is located lower than the actuating cylinder. In yet still another feature, the drag link element is connected to the first pivot arm at a distal pivot connection relative to the main pivot connection, and, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection.

In another aspect there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. It has first and second end sections to which the hopper is mounted, the first and second end sections being mounted to respective first and second railroad car trucks for rolling motion along railroad tracks in a lengthwise direction of the car. There is a door operating linkage connected to the gate, the door operating linkage being oriented lengthwise with respect to the car and connected. An actuating cylinder is connected to drive the door operating linkage. The actuating cylinder is also oriented to act in a lengthwise extending plane with respect to the car. The actuating cylinder has an axis of reciprocation. The door operating linkage includes a first pivot arm pivotally mounted to the first end section at a first pivot connection. There is a mechanical transmission connected between the first pivot arm and the gate. The mechanical transmission includes at least a drag link movably connected to the first pivot arm at a location distant from the first pivot connection. The first pivot connection is lower than the actuating cylinder as seen when viewing the first end section in side view.

In another feature of that aspect of the invention, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot con-

nection and the distal pivot connection. In still another feature, the actuating cylinder drives an intermediate lever that is connected to drive the first pivot arm.

In another aspect of the invention there is a rail road hopper car. It has a hopper carried between a pair of trucks, the hopper having first and second upstanding sidewalls running lengthwise therealong. The hopper has a lower discharge and convergent slope sheets giving onto the discharge. The rail road car has a side sill and a top chord. The first upstanding sidewall extends from the side sill to the top chord. The first upstanding sidewall has a predominantly upwardly running sidewall stiffener mounted thereto. The sidewall stiffener is located at a longitudinal station intermediate the trucks. The first upstanding sidewall has a first region, the first region being a lower region thereof. The first upstanding sidewall has a second region. The second region is an upper region thereof. The sidewall stiffener has a first portion, the first portion being a lower portion thereof. The first portion is mounted to the first region of the first upstanding sidewall. The sidewall stiffener has a second portion, the second portion being an upper portion thereof. The second portion is mounted to the second region of the upstanding sidewall. The first portion of the first upstanding sidewall stiffener is laterally outboard of the first region of the first upstanding sidewall. The second portion of the sidewall stiffener is laterally inboard of the second region of the first upstanding sidewall. The sidewall has a continuous section between the first and second regions thereof. The sidewall stiffener has web continuity between the first and second portions thereof.

In a feature of that aspect of the invention, the first and second portions of the sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and the stiffener has vertical web continuity through the transition portion. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof. The hopper includes first and second sloped side sheets. The first sloped side sheet meets the first sidewall at the transition portion. In another feature, the first sidewall has an overall height from the side sill to the top chord, L, and the transition is located a distance above the side sill that is in the range of ¼ to ⅔ L. In a still further feature the first sidewall has an overall height from the side sill to the top chord, L, and the first sloped sheet meets the transition at an height that is in the range of ¼ to ⅔ L above the side sill.

In a further aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge having a bottom discharge governor movable between a closed position for retaining lading and an open position for permitting egress of lading. The car has structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has a door operating linkage oriented lengthwise with respect to the car. There is an actuating cylinder also oriented to act in a lengthwise extending plane with respect to the car, the actuating cylinder being connected to drive the door operating linkage. The door operating linkage includes a pair of first and second linkage members co-operably mounted to either transverse side of the actuating cylinder, whereby the actuating cylinder is bracketed by the linkage members.

In another feature of that aspect of the invention, the car has an underframe and the linkage is a closed loop bar linkage in which there is a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, and which includes the first and second linkage members, the first and second linkage members being a matched pair of left and right hand pivot arms constrained to pivot on a common axis of rotation relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and which includes at least one pivotally mounted door assembly defining the bottom discharge governor. The third linkage component includes a drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator.

In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. Displacement of the third linkage component associated with motion of the door assembly between the open position is predominantly in a direction generally parallel to the end slope sheet. In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. During at least an instantaneous portion of motion of the third linkage component while the door assembly is in a position between the open position and the closed position the third linkage component moves parallel to the end slope sheet. In still another feature the third linkage component includes at least a first element and a second element mounted thereto. The first element is pivotally mounted to the first linkage component, and is constrained to move in a lengthwise-vertical plane relative to the first linkage component. The second element has a first connection to the first component the first connection being a pivot connection. The second element has a second connection to the fourth linkage component, the second connection having at least one degree of freedom of motion. The second element is constrained always to be coplanar with the first connection, the second connection, and the main pivot connection. In yet still another feature, the bottom discharge governor includes a door. The actuating cylinder is connected to drive the door operating linkage through a lever assembly. The lever assembly has an overcenter lock that is operable to prevent release of the bottom gate to the open position when the actuating cylinder is inactive. In yet a further feature, motion of the first pivot linkage occurs in a longitudinal-vertical plane. The second pivot linkage moves in a plane generally cross-wise to the longitudinal-vertical plane. In still a further feature the main pivot connection is beneath the actuating cylinder when the hopper car is seen in side view. In again another feature one of (a) the main pivot is beneath the drag link element; and (b) the actuating cylinder is between the main pivot and the drag link element. In a yet still further feature, the hopper includes at least a first end slope sheet, and the bottom discharge governor includes a door. The first end slope sheet is inclined longitudinally

downwardly and inboard toward the door. The drag link element is inclined on a slope predominantly parallel to, and adjacent to, the first end slope sheet. The actuating cylinder is oriented along the lengthwise direction, and is also tilted longitudinally downwardly and inwardly toward the door.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper carried by railroad car trucks for motion in a lengthwise direction of the car along railroad tracks. The hopper has a bottom discharge. The bottom discharge has a door movable between a closed position for retaining lading and an open position for permitting egress of lading. A mechanical transmission is connected to the door. The mechanical transmission is oriented lengthwise with respect to the car. A door actuator is connected to the mechanical transmission and is operable to urge the door from the open position toward the closed position, the door actuator being oriented to reciprocate in a first direction. The hopper car has a first lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. The hopper car has a second lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator.

In another feature of that aspect of the invention, the car has a central lengthwise-vertical plane, the door actuator is positioned to reciprocate in the central lengthwise-vertical plane, and the second lock is movable between the engaged and disengaged positions in motion predominantly transverse to the central lengthwise-vertical plane. In another feature, the second lock is mounted on an hinge and pivots in a circumferential direction between the engaged and disengaged positions. In still another feature the second lock is mounted on an hinge, the hinge has an axis lying parallel to the lengthwise vertical plane, and the second lock pivots circumferentially between the engaged and disengaged positions. In another feature, the second lock is biased toward the engaged position. In still another feature, the second lock is biased toward the engaged position. In yet another feature the apparatus is one in which one of: (a) the second lock has a cam and the actuator has a mating cam follower; and (b) the second lock has a cam follower and the actuator has a mating cam. The cam and cam follower are co-operable, and are oriented to deflect the second lock away from the engaged position as the door moves from the open position to the closed position thereof.

In another aspect of the invention, there is a lock mechanism for a door actuating transmission of a railroad gondola car, the door actuating transmission including a reciprocating actuating cylinder mounted to a datum structure, the cylinder being movable forward and backward in an axial direction. The lock mechanism has a body having a first fitting, a second fitting and a third fitting. The first fitting is a mounting by which to connect the lock mechanism to the datum structure. The second fitting is one of (a) a cam for co-operation with a member of the door actuating transmission, that member being a cam follower; and (b) a cam follower for co-operation with a member of the door actuating transmission, that member being a cam. The third fitting includes an abutment for co-operation with a mating fitting of the door actuating transmission. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction.

In another feature, the lock mechanism there has a bias member oriented to urge the third fitting toward the first position thereof. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure. In another feature, the first degree of freedom of motion is an angular degree of freedom, and the predominantly cross-wise motion is predominantly circumferential motion about an axis of rotation. In a feature the first fitting is an hinge, the axis of rotation is an axis of rotation of the hinge, and the axis of rotation of the hinge is substantially parallel to the axial direction of the door actuating transmission. In still another further feature, the first fitting of the lock mechanism includes an hinge and a footing of the hinge for mounting to the datum structure. The axis of rotation is an axis of rotation of the hinge, and the footing has a substantially planar footprint. The axis of rotation of the hinge is angularly inclined relative to the substantially planar footprint. In yet another feature, the lock mechanism has all or any combination of the forgoing additional features.

In still another aspect of the invention there is a railroad hopper car for carrying particulate material. The hopper car there has a hopper and first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction. The hopper is suspended between the first and second end sections. The hopper has a discharge section through which to release lading, and first and second end slope sheets oriented toward the first and second end sections, the slope sheets being inclined in the longitudinal direction to feed the discharge section. The first end section includes a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to either side of the draft sill, and a shear plate mounted to the draft sill and to the main bolster. The shear plate extends lengthwise along the draft sill and cross-wise from side to side of the hopper car. The first end slope sheet of the hopper overhangs the shear plate of the first end section. The hopper car is free of primary structure directly above the shear plate of the first end section under the overhang of the first slope sheet of the hopper.

In another feature of that aspect of the invention, there is one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall. In another feature, the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. In a further feature, the bolster has first and second laterally outboard distal ends, and

the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet.

In still another feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. In another feature, one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall; the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. The bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. The hopper car has a machinery space bounded by (a) the first slope sheet; (b) the shear plate of the first end section; (c) the end post; and (d) the corner posts, and the machinery space is free of any other primary structure.

In yet another feature the hopper car has at least one longitudinally hinged discharge door, the discharge door being movable cross-wise between open and closed positions. A longitudinally acting pneumatic actuator is at least partially lodged in the machinery space directly above the draft sill. In still yet another feature a brake reservoir is also at least partially lodged in the machinery space. In a yet further feature the shear plate is mounted above and to the main bolster and defines an upper flange thereof. The main bolster has a lower flange downwardly spaced from the upper flange, the lower flange terminating at respective distal end portions at either side of the car. The car includes a side sill running along the car between the first and second end sections. The side sill has an upper flange, the upper flange of the side sill being substantially co-planar and connected to the shear plate. The side sill has a lower flange, the lower flange of the side sill being substantially co-planar with a respective one of the distal end portions of the lower flange of the main bolster. In another further feature, the shear plate defines an upper flange of the draft sill whereby the draft sill upper flange, the shear plate and the side sill upper flange are all substantially co-planar. In another feature the machinery space is free of elephant ears.

In a further aspect of the invention there is a railroad freight car having a freight car body for carrying lading, the body being mounted on railroad car trucks for rolling motion in a longitudinal direction along railroad tracks. The car body includes a draft sill having a draft gear pocket for accommodating draft gear, and a shear plate overlying the draft sill and functioning as an upper flange of the draft sill. The draft sill has an inboard end oriented toward a truck center of one of the trucks, and an outboard end terminating at a striker. The draft sill has an underside and an access opening formed in the underside to admit entry of draft gear into the draft gear pocket from below. The car has a draft gear carrier plate. The carrier plate is mounted to the underside of the draft sill beneath the draft gear pocket. The carrier plate is removable to permit installation of the draft gear into the draft gear pocket. The car body has one of (a) an aperture formed in the shear plate over an inboard end region of the draft sill, the aperture permitting a portion of the draft gear to protrude upwardly therethrough during installation in the draft gear pocket; and (b) a coupler carrier seat defined in the draft sill longitudinally inboard of the striker, and a coupler carrier co-operable therewith, the coupler carrier being removable to permit installation of draft gear in the draft pocket, and, when the coupler carrier is installed, the coupler carrier providing a support for a coupler shank when the coupler shank is connected to the draft gear within the draft sill.

In another feature of that aspect of the invention the freight car has both (a) and (b). In another feature, there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In still another feature, the draft sill has a pair of vertically oriented, longitudinally running spaced apart side webs. The webs have a greater depth of section adjacent to the striker. The webs have respective first and second apertures formed therein. The first and second apertures define the draft gear retainer seat, and the retainer is a sideways slidable shaft that is movable to extend across the draft sill between the first and second apertures in the draft sill side webs. In a further feature there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In another further feature the draft sill has a centerplate centered on the truck center, rear draft stops are welded within the draft sill, and at least a portion of each of the rear draft stops extends longitudinally inboard of the truck center. In still another further feature, the car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of less than 50 inches; and (b) the freight car has a truck center to coupler pulling face length of less than 65 inches when the draft gear is fully extended in draft. In another feature, the railroad freight car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of about 38 inches (+/−2"); and (b) the freight car has a truck center to coupler pulling face length of about 53 inches (+/−2") when the draft gear is fully extended in draft.

These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations.

BRIEF DESCRIPTION OF THE FIGURES

The description is accompanied by a set of illustrative Figures in which:

FIG. **1** is a general arrangement, isometric view of a railroad freight car according to an aspect of the invention with all ancillary systems removed to leave only primary structure visible;

FIG. **2***a* is an isometric view of a sidewall of the gondola car of FIG. **1**;

FIG. **2***b* shows a side view of the sidewall of FIG. **2***a;*

FIG. **2***c* shows an end view of the sidewall of FIG. **2***a;*

FIG. **3***a* shows a perspective view of the end structure of the railroad freight car of FIG. **1**;

FIG. **3***b* is a side view of the structure of FIG. **3***a;*

FIG. **3***c* is a detail of the end structure of FIG. **3***b*, with the near side web of the draft sill removed to show the draft stop, center plate, and coupler relationship.

FIG. **4***a* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully open position;

FIG. **4***b* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in an intermediate position;

FIG. **4***c* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully closed position;

FIG. **5***a* is a side view of the door opening mechanism of FIG. **4***a;*

FIG. **5***b* is a side view of the door opening mechanism of FIG. **4***b;*

FIG. **5***c* is a side view of the door opening mechanism of FIG. **4***c;*

FIG. **6***a* is an end view of the door opening mechanism of FIG. **4***a;*

FIG. **6***b* is an end view of the door opening mechanism of FIG. **4***b*; and

FIG. **6***c* is an end view of the door opening mechanism of FIG. **4***c;*

FIG. **7***a* is a perspective view of a secondary lock mechanism for the door opening mechanism of FIG. **4***a;*

FIG. **7***b* is a plan view of the mechanism of FIG. **7***a;*

FIG. **7***c* is a perspective view of the mechanism of FIG. **7***a* when the door are open

FIG. **7***d* is a view similar to FIG. **7***c*, of the mechanism of FIG. **7***a* in a deflected condition; and

FIG. **7***e* is a perspective view of the mechanism of FIG. **7***a* in a locked position;

DETAILED DESCRIPTION

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings may be taken as being to scale unless noted otherwise.

The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the rail road industry in North America. Following from decision of the CAFC in *Phillips* v. *AWH Corp.*, the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record in accordance with In re Lee, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years experience in the industry in North America or in other former territories of the British Empire and Commonwealth.

In terms of general orientation and directional nomenclature, for rail road cars described herein the longitudinal direction is defined as being coincident with the rolling direction of the rail road car, or rail road car unit, when located on tangent (that is, straight) track. In the case of a rail road car having a center sill, be it a stub sill or a straight-through center sill, the longitudinal direction is parallel to the center sill, and parallel to the top chords. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail, TOR, as a datum. In the context of the car as a whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, or of the centerline of a centerplate at a truck center. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit. Pitching motion is angular motion of a railcar unit about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the rail road car described herein may tend to have both longitudinal and transverse axes of symmetry, a description of one half of the car may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. In this description, the abbreviation kpsi stands for thousand of pounds per square inch. To the extent that this specification or the accompanying illustrations may refer to standards of the Association of American Railroads (AAR), such as to AAR plate sizes, those references are to be understood as at the earliest date of priority to which this application is entitled.

Bottom dumping hopper cars, of which ore cars and coal cars may be examples, may tend to have either longitudinal doors or transverse doors. Longitudinal doors are oriented such that the doors operate on hinges or axes of rotation that are parallel to the direction of travel of the railroad car generally. U.S. Pat. No. 4,250,814 of Stark et al., issued Feb. 17, 1981 and U.S. Pat. No. 3,800,711 of Tuttle, issued Apr. 2, 1974 show cars with longitudinal doors. By contrast, transverse doors are ones in which the axes of rotation of the hinges or other pivots tend to be predominantly cross-wise to the direction of travel, most often perpendicular to it. An example of a transverse door car shown in U.S. Pat. No. 4,843,974 of Ritter et al, issued Jul. 4, 1989.

FIG. **1** shows an isometric view of an example of a rail road freight car **20** that is intended to be representative of a range of rail road cars in which one or more of the various aspects of the present invention may be incorporated. While car **20** may be suitable for a variety of general purpose uses, it may be taken as being symbolic of, and in some ways a generic example of, a flow through car, in which lading is introduced by gravity flow from above, and removed by gravity discharge through gated or valved outlets below. Flow through, or center flow cars may include open topped hopper cars, grain cars, plastic pellet cars, potash cars, ore cars, coal gondolas, and so on. In one embodiment car **20** may be a hopper car such as may be used for the carriage of bulk commodities in the form of a granular particulate, be it in the nature of relatively coarse gravel or fine aggregate in the nature of fine gravel or sand or various ores, ore concentrate or coal. The principle, or primary, structure of car **20** may be symmetrical about both its longitudinal and transverse, or lateral, centerline axes. Consequently, it will be understood that the car has first and second, left and right hand side beams, bolsters and so on.

By way of a general overview, car **20** may have a car body **22** that is carried on trucks **24** for rolling operation along railroad tracks. Car **20** may be a single unit car, or it may be a multi-unit car having two or more car body units, where the multiple car body units may be substantially permanently connected at an articulated connector, or by draw bars, as opposed to by ordinarily releasable AAR couplers. Car body **22**, and the various structural members and fittings described herein may be understood to be typically of metal construction, whether welded or Huck™ bolted, or riveted together, the metal members being most typically steel, stainless steel, or aluminum, as may be appropriate. Some car builders have also used reinforced plastic composites for car elements, and those materials could also be employed where suitable. The default construction may be taken as being steel, of which the majority may be mild steel having, typically, a 50 kpsi yield. Car body **22** may have a lading containment vessel or shell **26** such as may include an upstanding wall structure **28** which

may have a pair of opposed first and second end walls **30**, **32**, that extend cross-wise, and a pair of first and second side walls **34**, **36** that extend lengthwise, the end walls **30**, **32** and side walls **34**, **36** co-operating to define a generally rectangular form of peripheral wall structure **28**. Wall structure **28** may include top chords **38** running along the top of the walls, and side sills **40** running fore-and-aft along lower portions of the side sheets or side sheet assemblies **42** of side walls **34**, **36**. In some instances, such as that of the illustration of FIG. **1***a*, car **20** may have stub center sills **44** at either end, in which case side walls **34**, **36** may act as deep beams, and may carry vertical loads to main bolsters **90** that extend laterally from the centerplates. In the case of a single, stand alone car unit, draft gear and releasable couplers may be mounted at either end of the stub center sill. In a center flow, or flow through car, the upper portion of the car may typically include means by which to admit lading under a gravity drop system. Such an intake **46**, or entryway may be a large rectangular opening such as that bounded by top chords **38**.

Car body **22** may include end sheets **48** and side sheets **50**. Car **20** of FIG. **1** et seq., is illustrated as a car having a single hopper **52**, a single hopper discharge section **54**, and an outflow or discharge governor in the nature of a discharge door assembly **56**. However, car **20** could, alternatively, be a multiple hopper car. In a multiple hopper car, the car may have laterally extending members or reinforcements, which may be cross-bearers, or cross-bearers with shrouds, or merely shrouds, particularly where the car is a multiple hopper car. These cross-members may run fully across the car from side sill to side sill, and may intersect the center sill, or the center sill shroud as may be. The car may also include upper wall bracing, in the nature of diagonal struts which extend diagonally upwardly and outwardly from the apices of the respective cross-members at the centerline of the car to upper regions of the side walls near or at the top chords; and lateral ties or struts that run across the car from sidewall to side wall to meet the upper ends of the diagonal struts at their wall brackets. Those brackets may be aligned with, and mated through the wall to, the vertical exterior posts that run from the side sill to the top chord and reinforce the walls.

End sheets **48** may be substantially planar slope sheets or slope sheet assemblies that are inclined downwardly in the longitudinally inboard direction to feed the discharge section. Not atypically, each pair of fore- and aft opposed slope sheets may be inclined at equal and opposite angles, and the angles of those sheets may be selected to be somewhat steeper than the free slope angle, or natural talus slope angle of the lading for which the car is designed, such that, when the gates are opened, the lading may tend to flow out, rather than sit at rest.

The primary structure of body **22** of car **20** includes lading containment vessel **26** which is in the nature of hopper **52**. Hopper **52** has an upper portion **58** with substantially vertical wall panels, and a lower stationary portion defined by a set of converging sloped walls, namely the side and end slope sheet assemblies **48** and **50**. At the lower margin of the sloped walls there is the outflow governor, namely door assembly **56**, which, in this instance, may have the form of a pair of first and second, or left and right hand doors **62**, **64**. This containment structure seats on, and is carried by, a pair of first and second end structures, **66**, **68**, at either end of the car. End structures **66**, **68** are in turn carried by trucks **24**. A door operating apparatus or mechanism, or drive train, or transmission, however it may be termed, and identified generally as **70**, is provided to move doors **62**, **64** between open and closed positions.

Considering this structure in greater detail, trucks **24** are most immediately surmounted by center plates **72** of longitudinally extending stub sills **44**. Stub sills **44** in turn carry laterally extending main bolster of main bolster **90**. Arms **74** extended perpendicularly away from the centerplate **72**, i.e., they are centered on the truck center, CL-Truck. Side sills **40** run lengthwise along the car between, and tie together, the most laterally outboard extremities of main bolster. A shear plate **76** is mounted in an x-y horizontal plane defining the top cover plate of stub sill **44**. Shear plate **76** extends laterally from side sill to side sill, and longitudinally from the fore-and-aft end slope sheet **48** to the laterally extending end sill **78** of the car, which, in this instance may be an upturned flange formed on the longitudinally outboard margin of shear plate **76**. In car **20**, the primary structure includes an end post **80** and a pair of side or corner posts **82**, **84**.

End post **80** is rooted in shear plate **76** in line with center sill **44**, and may have lateral webs or gussets aligned with the webs of stub sill **44** to provide vertical web continuity across shear plate **76**. End post **80** then extends fully between shear plate **76** and top chord **86** of end wall **30** or **32**, as may be. Corner posts **82** and **84** are rooted to, and stand upwardly from, the junction of the laterally outboard ends of left and right hand main bolster and side sills **40**. Posts **82** and **84** extend upwardly from this junction to mate with various elements of the end and side walls, as may be described below.

As described in additional detail below, car **20** has an abnormally short distance from the striker **88** to the truck center, i.e., the CL of centerplate **72**. Striker **88** is the vertical planar surrounding face plate at the outboard end of the stub sill **44**. In the terminology of the industry, the portion of the center sill **44** (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center CL-Truck may also be referred to as the draft sill. In car **20**, the short draft sill length, identified as L_{88}, leaves an anomalously small space in which to install other systems, such as the brake reservoir and the door operating pneumatic cylinder. Car **20** has an end of car machinery space, indicated generally as **75**, that is bounded by shear plate **76** on the bottom, the sloped end wall assembly **30** or **32** of the car on the top, main vertical central end post **80**, and main side posts **82**, **84** at the ends of main bolster **90**. This space may be referred to as having the shape, generally, of a triangular prism and is substantially unobstructed by the primary structure of the car. For the purposes of this description, primary structure is defined as the underframe, including side sills and center sill (i.e., including the draft sill), the side walls, the slope sheets and top chords, the hopper construction including the stationary parts of the discharge section, as well as any cross-bearers, cross-ties, bolsters, shear plates and so on. Primary structure excludes secondary or ancillary structure or systems such as ladders, cat-walks and other safety appliances, brakes, brake rods and brake fittings, air hoses, reservoirs and pneumatic fittings, movable door members, door operating linkages, and so on.

In existing cars, this space, **75**, is often occupied or otherwise obstructed by other primary structure, such as so-called "elephant ears". In this context, "elephant ears" are large, substantially triangular planar plates, sometimes provided with central lightening holes, that have one edge fixed along the junction of the center sill webs and the center sill cover plate, and another edge welded to the end slope sheet. The third edge is typically a free edge. Often these plates lie in a plane that is oriented at an angle to the vertical—i.e., it leans laterally outboard. Car **20** avoids the use of these "elephant ears" and so provides the large unobstructed space shown in FIG. **1***b*.

FIGS. **1** and **2***a*, **2***b* and **2***c*, all show the sidewall of the car, indicated generally as **34** or **36**. Sidewall **34** and **36** function as short beams of low (e.g., less than 4:1, possibly less than 3:1) length-to-depth ratio. Sidewall **34** or **36** can be seen to have a bottom flange or chord member, namely side sill **40**, a top flange or chord member, namely top chord **38**, which may have the form of a square or rectangular hollow structural steel tube; and an intermediate shear force transfer web, namely side sheet assembly **42**. Side sheet assembly **42** may include an upper sheet portion or member **92** that is welded to the outside face of top chord **38** at a lap joint, and that extends downwardly therefrom; and a lower sheet portion or member **94**. Member **94** may have the form of a Z-section, having a first portion, namely an upper flange or leg or margin **96** that extends in a substantially vertical plane and has an uppermost margin that overlaps the lowermost edge or margin of member **92**; a second or intermediate portion **98** that runs in an inclined plane sloping inwardly and downwardly on the slope of the hopper side sheets generally, and a third or bottom portion, namely bottom flange, or leg, or margin **100** that extends in a substantially vertical plane downwardly. Sidewall **34** or **36** also includes a central post, or web stiffener, **102** that has a lowermost first portion **104** an intermediate second portion **106**, and an uppermost third portion **108**.

Side sill **40** includes a channel **110** that is welded toes-inward against the lowermost marginal portion of lower leg **100** to form a closed section. The first or lowermost portion **104** of web stiffener **102** has the form of a quadrilateral gusset having a first edge welded to the upper leg of channel **110**, a second edge welded to the vertical margin **100**, a third edge welded to the sloping portion **98**, and the fourth, laterally outboard, edge being free. As may be noted, portion **104** stands outboard of the sidewall sheet.

Portion **108** is a rectangular web stiffener that is welded to, and extends downwardly from, the underside of top chord **38** along the inside face of vertical web portion **92**. Intermediate portion **106** is a web, or plate, or gusset, that is also a quadrilateral, having a first edge that overlaps, and is welded to, the lower margin of portion **108**. A second edge is welded to the lower region of vertical web portion **92**, and to the upper flange or leg **96**. A third edge is welded along the sloped portion **98** of member **94**. The fourth edge is free, and faces inwardly into the lading containment space of the hopper. Portions **104** and **106** are co-planar, or substantially co-planar, such that stiffener **102** has web continuity through member **94**. The upper margin of the side slope sheet **50** of the hopper discharge section is welded to the lower margin of the inclined or sloped portion **98**, such that the structure presents a continuous sloped surface for containing, and then slidingly discharging, particulate lading. Expressed differently, the web of the sidewall traverses the sidewall stiffener, commencing on its inboard margin at side sill **40**, traverses the web mid-way up the post, and ends along its outboard margin at top chord **38**. In this arrangement, the vertical stiffener, **102**, acts as the web of a T-section, and the local region of the wall section to which it is joined functions as the flange of that T-section.

In this example, the locus of intersection of the side slope sheet plane P_{94} with the plane of the side wall sheet P_{92}, lies above the level of side sill **40** by a substantial distance, indicated as L_{94}. This distance may lie in the range of ¼ to ⅔ of the distance L_{SW} from side sill **40** to top chord **38**, and, in the particular may be about ⅓ of that distance. Further, although the post has stiffening member web continuity in a vertical plane, the wall sheet traverses the stiffening web intermediate the top chord and the side sill, and does so obliquely on the slope of plane P_{94}.

The upper leg of channel **110** forms the upper flange of side sill **40**, and the lower leg of channel **110** forms the lower flange of side sill **40**. Shear plate **76** forms the top flange of main bolster **90**. Main bolster **90** also has a lower or bottom flange **91**. In car **20** the upper leg of channel **110** is co-planar or substantially co-planar with, and is connected in flange continuity with, shear plate **76**. Similarly, the lower leg of channel **110** is co-planar or substantially co-planar with, and connected in flange continuity with, bottom flange **91** of main bolster **90**.

Continuing with the sidewall assembly, the main sheet, namely upper sheet portion **92**, ends at the corners, and there are respective first and second end upper web stiffener portions and inwardly stepped plate members **112**, which may be termed "ears". The top edge of each ear is welded to the inside face of top chord **38** in a lap joint. The longitudinally outboard end edge forms a plane to which the vertical end sheet of the end slope sheet wall abuts and is welded. The bottom edge follows the slope of, and is welded to, end slope sheet **48**. The forward, transversely outwardly bent edge is welded to the upper end portion of side sheet assembly **42**. The lower region of the main sidewall sheet also includes lightening apertures **114**, in the space between the corner posts and the slope of the end slope sheets. Finally, the lower portion of region **100** of the main sidewall sheet has longitudinal extensions **116** that are welded to the side edges of the shear panel, namely shear plate **76**, outboard of main bolster **90**, thereby forming a portion of the peripheral flange of the shear plate.

End walls **30**, **32** each include upper and lower sloped surface members **122** and **124**, which could be made as a single piece, or as two pieces butt-welded together, as here. Upper member **122** has notches **126** formed therein to accommodate corresponding corner posts **82**, **84** as may be, with local reinforcement doublers **128** at the junction. Lower portion **124** tapers in width to match the narrowing width between the sloped side sheets with which it mates. At the upper end of end wall **30** the end wall assembly includes a laterally extending first formed member **130** that has a first, vertical leg **132** that laps the inside face of the top chord **86**, and a bent flange **136** that extends initially horizontally, with a distal lip bent upward to mate perpendicularly with the upper margin **138** of the end slope sheet **48**. The distal tip of end slope sheet **48** is fillet welded to vertical leg **132**. This results in a substantially triangular closed section defining a laterally extending end slope sheet reinforcement beam **140**. The ends of this beam abut, are welded to, and are capped by elephant ears **112**. Vertical leg **132** also lies against, and is welded to, end post **80**.

A formed angle **142** is mounted toes-in at an intermediate height on sloped end wall **48**, forming thereby another hollow section laterally extending end sheet reinforcement or beam **148**. Vertical leg **144** of angle **142** is substantially aligned with the central web of the corner post (be it **82** or **84**) and therefore also with the central web of the main bolster. Another formed angle **150** is welded toes-in to the back of sloped end wall **30** at the level of shear plate, thereby forming yet another slope-sheet reinforcement in the form of a laterally extending beam.

The corner posts **82** and **84** each have a lower corner post flange plate **160** (that includes a lifting lug aperture) that has a bottom tab welded to the outside, or back, of the end of side sill **40** in line with the main bolster, then an angled portion following the angle of the outside edge of the vertically extending side wall reinforcements, **161**, to an upper end at the juncture of the side slope sheet with the side wall vertical leg of the lower side wall sheet. Each end post has two internal reinforcements **154**. Each corner post also includes an intermediate member, or web, or gusset, or plate **162**, which is

considerably wider than intermediate gusset **106**, and a substantially triangular inside edge web stiffener **164**. Plate **162** is a quadrilateral. A first edge of plate **162** runs along the upward and outward slope of wall extension **166**. A second edge runs vertically against the upper leg of wall extension **166**. A third upper edge adjacent runs horizontally along lateral reinforcement beam **148**. The fourth edge runs vertically downward to and along edge stiffener **164**. As such, a vertical post is established.

Considering FIGS. **3***a*, **3***b* and **3***c*, center sill **44** includes a bottom flange or bottom cover plate **165**, and a pair of spaced apart webs **168**. The central region of shear plate **76** forms the top flange, or top cover plate of the center sill. At its inboard end, the center sill terminates centrally under the bottom lateral reinforcement of the end slope sheet **48**. A draft pocket **175** is defined between webs **168**, shear plate **76** and bottom cover plate **165** longitudinally inboard of the striker plate.

Center plate **72** is mounted at truck center CL-Truck, in line with main bolster **90** and the corner posts **82**, **84**. Rear draft stops **172** are welded within the center sill above center plate **72**. As seen in FIG. **3***c*, the inboard end of rear draft stop **172** extends longitudinally inboard of the truck center. While this is known to have been used in at least one single piece, integrally cast draft sill, the inventor is unaware of such a construction in an all-welded fabrication draft sill assembly. The removable draft sill access cover plate, or draft gear carrier plate **174**, which is bolted to the draft sill (i.e., the stub sill) bottom flange margins, is mounted immediately longitudinally outboard of center plate **72**. Front draft stops **176** are, in turn, mounted longitudinally outboard of carrier plate **174**. In this embodiment there is also a removable member, such as a top leeway or access plate **178**, mounted to shear plate **76**. Plate **178** is removed when draft gear **180** is removed or installed. On installation, draft gear **180**, to which yoke **188** is already mounted, is fed into draft pocket **175** from below, on an angle, whereby the rear corner protrudes upwardly through the opening that is otherwise covered by plate **178**. The front end of draft gear **180** is rotated into place, and the rear end is rotated downward. As this occurs, yoke **188** is also raised into place. Plates **178** and **174** are then reinstalled. The shank **182** of the coupler, **184** is inserted, and the coupler key **186** is fed through the slot in front draft stops **176** to link coupler **184**, and yoke **188** in the customary manner. It may be noted that coupler **184** combines an AAR Type E shank with and AAR Type F knuckle with a bottom shelf. Draft gear **180** itself has abnormally short travel, namely about 2½ inches deflection before going solid, as compared to a "normal" deflection of over 3" before going solid.

Draft sill webs **164** have, at their longitudinally outboard end an end portion **190** of increased depth of section with a downwardly protruding bulge or horn, such as might be termed a "chin". End portion **190** has an aperture or slot **192** formed therein to permit lateral sliding insertion of a coupler support, carrier or bar **194** immediately behind striker plate **88**. Removal of bar **194** permits yoke **188** to be swung into place during installation of draft gear **180**. When coupler **184** is installed, the shank may rest on bar **194**. Bar **194** is held in place by bolts that secure it relative to webs **164**. Overall, a coupler installation of very short length is achieved. In this example, L_{88} may be in the range of less than 50 inches, and in one embodiment may be about 38"+/−2", from the truck center to the outboard face of striker plate **88**. An alternative expression of the relative compactness of the draft gear is that the length from the truck center to the pulling face of the coupler, when the draft gear is extended in tension, is in the range of less than 65 inches, and in one embodiment is in the range of 53"+/−2".

Car **20** may also include a door opening mechanism **200**. There are left and right hand, or first and second, doors **62**, **64**. Each door has a proximal, hinged edge **206**, and a distal free edge **208**. The hinges are carried on hinge fittings welded to mounting brackets depending from the slope sheets and side sills. The hinges run parallel to the longitudinal or lengthwise axis of the car, generally such that doors **62**, **64** are longitudinal doors. Each door has the form of a hollow section beam, having a proximal beam **210** along the hinge side, a distal beam **212** along the free edge, internal cross-braces, not shown, and front and back skins or sheets or plates **214**, **216**. The hinges are indicated as **220**, the end closure plates as **222**, **224**. The doors have door seal members **226**, **228** that mutually engage when the doors are moved to a closed position. Seal members **226**, **228** are sprung, such that when they are closed they deflect somewhat and in so doing take on a spring pre-load against each other. The door mechanism includes a pair of first and second, matched left and right hand pivot arms **230**, **232**; a corresponding pair of first and second drag links **234**, **236**; a shared yoke **238**, and a pair of slave links **240**, **242** that each pick up on a knuckle fitting **244**, **246** of each of respective doors **62**, **64**. The whole assembly has left and right hand symmetry.

Inasmuch as, when tripped, doors **62**, **64** open under the influence of gravity, particularly when assisted by the weight of the lading being discharged, one may consider the motion that occurs as the doors are closed in the sequence of views **4***a*, **4***b*, and **4***c*; **5***a*, **5***b*, and **5***c*; and **6***a*, **6***b* and **6***c*. Knuckles **244** and **246** are constrained by geometry to move in circular arcs of fixed radii in planes perpendicular to the respective axes of rotation of doors **62** and **64**, those axes being the hinge axes of their respective hinges **220**, which each lie in a plane parallel to the x-z plane of the car centerline. The plane of rotation of knuckles **244**, **246** will then tend to be perpendicular to the central x-z plane. Slave links **240** and **242** are each of fixed length; each has an end pivotally connected at a two rotational degree of freedom knuckle, be it **244** or **246**, as may be; each of slave links **240** and **242** has another end pivotally connected at a second pivot connection at yoke **238**; and slave links **240** and **242** do not transmit a bending moment, and so therefore pull in pure tension. The upper, or near (i.e., proximal), ends of drag links **234**, **236** are connected to the distal ends of pivot arms **230**, **232** at pivot connections **248**, **250**, which may, if desired, share a common axis of rotation or pivot pin.

Yoke **238** is constrained by symmetry to pull in an x-z plane, which in the embodiment illustrated is the vertical plane of the centerline of the car. As such, movement of yoke **238** away from the plane of motion of knuckles **244** and **246** will necessarily draw knuckle fittings **244** and **246** closer together, and toward the vertical centerline plane of the car, eventually causing resilient door seals **226**, **228** mutually to engage, thus closing the opening. This motion can be achieved by pulling on drag links **234**, **236**. Each pivot connection of slave links **240**, **242** has a single angular degree of freedom. Similarly yoke **238** has an angular degree of freedom about the axis of rotation of the axle, or trunnions, by which it is pivotally mounted to the drag link, or drag links **234**, **236**. This gives the drag link connection two angular degrees of freedom in total. As the drag links are withdrawn, the slave links pull in tension, finding the natural hypotenuse between the plane of the arc of motion of knuckle fittings **244**, **246** and the plane of motion of drag links **234**, **236**. Since this mechanism operates in tension, pivot connections **248**, **250** and knuckle fittings **244**, **246** are co-planar, with drag links

234, 236, yoke 238, slave links 240 and 242, and their associated pivot connections also lying in that same plane as well. (See FIGS. 5*a*, 5*b*, 5*c*).

Driving force for this system is provided by an actuator, identified as 260. Actuator 260 may be a pneumatic actuator, which may be charged by the pneumatic system of the train generally, as supplied through the pressurized air connection of the train line. Actuator 260 may include its own reservoir and check valve. Actuator 260 is connected to move a first member, in the nature of a primary driven pivot arm or lever, 262, which is in this instance actually a pair of matched lever arm members, which in turn is pivotally connected to, and drives, a second member in the nature of, a push rod, or, given the symmetrical nature of the assembly, a pair of left and right hand push rods 264 and 266. One or both of push rods 264, 266 may have a secondary member, such as may be an extending arm, or detent, or stop, or abutment, identified as an over-center travel limiter or governor, 268. The far ends of push rods 264, 266 may be connected to either pivot (or 232, as may be), or to drag link 234 (or 236, as may be). It may be convenient to connect the far end of push rods 264, 266 at the same pivot connection, or connections 248, 250.

Lever 262 has a first end pivotally mounted to primary structure of car 20 at footings, identified as mounting fixtures, fittings or brackets 270. The drive rod of actuator 260 picks up on lever 262 at an intermediate location, such that lever 262 provides magnification of displacement. Similarly, pivot arms 230, 232 have a first or base end pivotally connected to primary structure at mounting fixtures, fittings, or brackets 272. Actuator 260 is located on the centerline (i.e., in the central x-z plane) of car 20, between and in substance below pivot arms 230, 232. "Below" in this context may be thought of as radially more proximate to the pivot axis P_{270} of brackets 270 than is the pivot axis of connections 248, 250, as well as in the context of being lower than as in closer to Top of Rail. In the past the lever fitting has more commonly been mounted to the slope sheet such that the output pin is lower than the pneumatic cylinder. Turning this arrangement upside down, in effect, and fitting the cylinder may then permit a more compact installation than otherwise. Similarly, the pivot axis, P_{230}, of driven arms 230, 232 is below the output knuckle, i.e., at P_{250}, and is below the actuator cylinder as shown in FIG. 5*b* in which P_{250} lies below the center line CL_{260} or actuator 260. This may be taken in the sense of being further from the plane of the end slope sheets, identified as P_{48}. Expressed differently, actuator 260 lies between the base or datum pivot point P_{250} of driven arms 230, 232 and the plane P_{48} of end slope sheet 48.

As may be noted, the line of action of drag links 234, 236 has a predominant component that is substantially parallel to plane P_{48}. Expressed differently, at some point during mid-stroke, the line of action will be at least instantaneously parallel to plane P_{48}. Finally, it may be noted that rather than placing actuator 260 on shear plate 76, and orienting actuator 260 such that its longitudinal axis (i.e., the working axis or axis of reciprocation of the actuator), that actuator is itself raised upwardly from the shear plate and oriented to work along a line of action that is tilted downward and longitudinally inboard, the angle of tilt being identified as α_{260}. This angle of inclination lies in the range from horizontal to the angle of inclination of end slope sheet 48, identified in FIG. 5*c* as α_{48}. Placing the mounts and pivot points under the apparatus, raising the actuator cylinder, orienting it on an incline, and making the line of action or the zone swept by the draglinks in the progressions of FIGS. 4*a*, 4*b* and 4*c* (or 5*a*, 5*b* and 5*c*) tend to correspond to a displacement substantially or predominantly parallel to plane P_{48}, all aid in providing a more compact installation, in particular one that is longitudinally short as may suit the short distance from the truck center to the striker. It is also an installation that may tend to leave space for other car systems, such as the brake system.

This arrangement may be thought of in terms of a four bar, or multi-bar, linkage. The first bar of the linkage may be thought of as being the underframe, and structure rigidly mounted to the underframe. This is the datum, or frame of reference member of the linkage. The second member or linkage component is the first pivot arm, 230 (or 232) having a fixed main pivot point, and an output distal pivot point constrained to move on a fixed radius about main pivot point P_{230}. The fourth component or element of the linkage is the second pivot arm, namely 62 or 64, each of which is a second lever or pivot arm mounted to a pivot axis fixed with respect to the first or datum link, and having a distal connection, in this case also a pivot connection, constrained to move in an arc of constant radius about the base pivot axis. The third linkage is the drag link. Although the drag link is made of two portions that are held together at yoke 238, the geometric symmetry of the assembly constrains both the upper portion of the drag link, (i.e., drag link 234, 236) and the lower portions, (i.e., slave links 240, 242) to be co-planar during closing of the doors. In any case, the single input of the actuator cylinder acting through the over-center links against the first pivot arm (at the distal pivot connection) produces a unique output geometry such that position of the elements is determinate as if it were a four bar linkage.

When the door opening apparatus is retracted to the position shown in FIGS. 4*c*, 5*c* and 6*c*, driven primary pivot arms and the over-center links are driven to a slightly over-center relationship such that the pivot connection between the primary pivot arms and the over center arms lies below a line drawn from the primary pivot axis and the over-center link output connection as axis P_{250}. In this condition tensile force on drag links 234 and 236 (as from weight placed on doors 62, 64, for example) will tend to urge the main driven pivot arms, namely lever 262, counter-clockwise as viewed in FIG. 4*c*. Motion in this direction is prevented by the over center stop, 268, thereby defining a first lock that prevents inadvertent opening of doors 62, 64 from moving to the open position when actuator 260 is dormant, i.e., inactive. This first lock is released by reversing actuator 260 to open the doors.

Car 20 has a secondary door mechanism, or secondary latching system, identified generally as 300. This secondary latch system, and, indeed, the door closure linkage apparatus of FIGS. 7*a*-7*e*, are slightly different from those shown in FIGS. 4*a*, 5*a*, and 6*a*. In latching system 300 there is a latch assembly 302, shown in FIGS. 7*a* and 7*b*. Assembly 302 includes a first member, or main member, or plate 304, which performs the function of a body or armature or spider that ties the other various physical elements of the assembly together. Along one edge plate 304 has physical motion constraint fittings, identified as hinge fittings 306, that limit plate 304 (and assembly 302 more generally) to a single degree of freedom, that single degree of freedom limiting plate 304 to motion of any point to motion in a plane perpendicular to the hinge axis, and in particular to pivotal motion in that plane about that axis. To the extent that the hinge axis is substantially or predominantly parallel to the axis of reciprocation of pneumatic actuator 260, that motion can be said to be sideways, or predominantly transverse of cross-wise to that direction of reciprocation.

Plate 304 has a portion or finger, or arm member 308 extending away from the hinge. In this case, arm member 308 extends arcuately away, and has a bent termination, or end, or lip, or tip, indicated at 310. Another member 312 in the form

of a block is mounted, e.g., welded, at the distal end of arm member **308**. Member **312** has the same general shape, a dog-leg bend, as tip **310**. Member **312** has a first, generally inwardly (i.e., away from the tip) facing surface **314** that defines an abutment **316**. Member **312** also has an oblique surface **318** that defines a wear or cam surface, which may be termed a reset cam, or return cam.

Another member **320**, which may have the form of a plate or block, is welded to the major portion of the body of plate **304** relatively close to the hinge axis. The axially foremost face of member **322** is relieved—i.e., it does not define a face in a plane perpendicular to the hinge axis—or to the axis of reciprocation of the pneumatic actuator clevis. This face may be arcuate or chamfered, and so defines a first or deflection cam **324**. That is, as installed, it lies in the path of actuator clevis **330**. When the leading corner of clevis **330** encounters cam **324**, plate **304** will tend to be urged to rotate, i.e., pivot, about its axis in the clockwise direction as viewed looking from actuator **260** toward hopper **52**. Assembly **302** also includes a motion resisting, or return biasing member in the form of a spring, identified as leaf spring **326** that is anchored at the proximal end to stationary structure of the secondary lock footing, or base, **328** which is welded to shear plate **76**. The footprint of base **328** against shear plate **76** is planar. The hinge axis is inclined relative to the plane as shown, the angle of inclination being substantially similar to, and possibly the same as, the mid-stroke angle of inclination of actuator **260** (which, itself, varies slightly during operation). The distal end of spring **326** bears against plate **304** distant from the hinge. Finally, assembly **302** includes reaction force transmission members **332**, **334** in the form of welded flat bars that bear against, i.e., abut, the longitudinally outboard face of mounting fitting **270** when the latch is in the engaged position.

In operation, as actuator **260** works, lost motion is taken up in slot **336** of the distal or forward end **338** of the reciprocating actuator ram. Eventually the end of slot **336** engages a pivot pin **340** of bell crank arm **342** and causes driven member **344** (analogous to driven member **262**), causing it to rotate counterclockwise as viewed in FIG. **7***a*. This forces push rods **346**, **348** (analogous to push rods **264**, **266**) to act against connections **248**, **250**, and hence to force drag links **234**, **236** along their retracting path. Since **262**, **264**, **230** and the car body form a four bar linkage, the output path of connections **248**, **250** is determinate and unique.

While this happens, clevis **338** keeps moving rearward to engage reset cam surface **318**, with the effect that assembly **302** is urged to rotate out of the way, against the resistance of spring **326** (FIG. **7***d*). Eventually the trailing portion of clevis **338** clears cam **324**, and soon thereafter the most longitudinally inboard edge of driven member **344** clears abutment **316**. Assembly **302** then moves under the influence of spring **326** into the locked position shown in FIG. **7***e*. In this locked position, any moment tending to pivot driven member **344** clockwise is reacted not by the hinge fittings, but rather by the reinforcements, namely members **332**, **334**. In this locked position driven member **344** and push rods **346**, **348** are drawn to, and locked in, their over center position.

When the doors are to be released, actuator **260** moves in the opposite direction. The lost motion of the length of slot **336** reverses, such that the end of clevis **338** bears against the release cam, namely cam surface **324**, which causes plate **304** to pivot away, and thus disengages abutment **316**, moving it out of the path of driven member **262** against which it would otherwise abut. The outboard end of slot **336** then engages pin **340**, releasing the over-center hold of driven member **344**, and permitting the doors to open under the influence of gravity.

The cams need not necessarily be on the plate, i.e., the latch body, but could be on the clevis, as shown at **350** in FIG. **4***c*. That is, it is to some extent arbitrary which part is identified as the cam, and which part is identified as the cam follower. The point is that the parts mutually engage such that the one intercepts the other during motion of the actuator cylinder to trip the door opening condition, with the result that the secondary latch is urged to deflect out of the way sideways. In the other direction, of course, the abutment relationship of items **262** and **316** prevents the doors from opening. The apparatus of FIG. **4***c* works in substantially the same way, and combines both arms of the bell crank driven member **344** into a single driven lever, namely lever **262**.

In summary, car **20** has a first lock, the over center lock, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. Car **20** also has a second lock, symbolized by latching system **300**, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator. Actuator **260** is positioned to reciprocate in the central lengthwise-vertical plane of car **20**. Latching system **300** is movable predominantly transverse to the central lengthwise-vertical plane as it pivots in a circumferential direction between the engaged and disengaged positions. The hinge axis lies parallel to the lengthwise vertical plane, and the second lock pivots circumferentially. The second lock is biased toward the engaged position. The lock mechanism can be thought of as having a first fitting, a second fitting and a third fitting. The first fitting is the mounting, **238** by which to connect the lock mechanism to the datum structure. The second fitting is one of a cam or a cam follower for co-operation with a member of the door actuating transmission. The third fitting is the abutment, i.e., **316**, that co-operates with a mating part of the door actuating transmission, in this case the side of lever **262**. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure, namely shear plate **76**. The first degree of freedom of motion is an angular degree of freedom, and is predominantly cross-wise circumferential motion. The axis of rotation is the hinge axis, which is substantially parallel to the axial direction of the door actuating transmission.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

We claim:

1. A rail road hopper car comprising:

a hopper carried between a pair of trucks, said hopper having first and second upstanding sidewalls running lengthwise therealong;

said hopper having a lower discharge and convergent slope sheets giving onto said discharge;

said rail road car having a side sill and a top chord;

said first upstanding sidewall extending from said side sill to said top chord;

said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;

said first upstanding sidewall having a first region, said first region being a lower region thereof;

said first upstanding sidewall having a second region, said second region being an upper region thereof;

said sidewall stiffener having a first portion, said first portion being a lower portion thereof, said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;

said first portion of said first upstanding sidewall stiffener being laterally outboard of said first region of said first upstanding sidewall;

said second portion of said sidewall stiffener being laterally inboard of said second region of said first upstanding sidewall;

said first sidewall having a continuous section between said first and second regions thereof; and

said sidewall stiffener having web continuity between said first and second portions thereof.

2. A rail road hopper car comprising:

a hopper carried between a first end section and a second end section;

said first and second end sections being carried by respective first and second trucks for rolling motion in a longitudinal direction along railroad tracks;

said hopper having first and second upstanding sidewalls running lengthwise therealong;

said hopper having a lower discharge and convergent slope sheets that slope downward toward said discharge;

said discharge having a door movable between a closed position and an open position to govern egress of lading from said hopper;

one of said convergent slope sheets being a first end slope sheet;

said first end slope sheet extending laterally between said first and second upstanding sidewalls;

said first end slope sheet having a first, lower, longitudinally inboard end proximate said discharge, and a second, upper, longitudinally outboard end distant from said discharge;

said first end section having a first draft sill and a main bolster extending cross-wise to said first draft sill, said first draft sill and said main bolster intersecting at a first truck center, said first truck being located centrally under said first truck center;

said draft sill having a striker longitudinally outboard of said first truck center;

said first end section having a shear plate mounted overtop of said first draft sill and said main bolster;

said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet;

said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;

said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;

said lower, longitudinally inboard end of said first end slope sheet being reinforced by a second cross-wise extending beam;

said first end slope sheet overhanging said shear plate;

a door actuator mounted above said shear plate, said door actuator being at least partially overhung by said first end slope sheet;

said door actuator being connected to said door by a mechanical transmission;

said first end section being free of longitudinally oriented elephant ears extending between said draft sill and said first end slope sheet;

said hopper having respective first and second top chords running longitudinally therealong;

said car having respective first and second side sills running longitudinally between said first and second end sections;

said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;

said first upstanding sidewall having a first region, said first region being a lower region thereof;

said first upstanding sidewall having a second region, said second region being an upper region thereof;

said first and second regions of said sidewall adjoining each other at a height intermediate said first side sill and said first top chord;

said second region of said sidewall extending downwardly or said first top chord;

said first region of said sidewall extending downwardly and laterally inboard from said second region of said sidewall;

said sidewall stiffener having a first portion, said first portion being a lower portion thereof,

said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;

said first portion of said first upstanding sidewall stiffener being laterally outboard of said first region of said first upstanding sidewall;

said second portion of said sidewall stiffener being laterally inboard of said second region of said first upstanding sidewall;

said first sidewall having a continuous section between said first and second regions thereof; and

said sidewall stiffener having web continuity between said first and second portions thereof.

3. The rail road hopper car of claim 2 wherein said first and second portions of said sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

4. The rail road hopper car of claim 2 wherein said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet

transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and said stiffener having vertical web continuity through said transition portion.

5. The rail road hopper car of claim **4** wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said transition portion is located a distance above said first side sill that is in the range of ¼ to ⅔ L.

6. The rail road hopper car of claim **2** wherein:

said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof;

said hopper includes first and second sloped side sheets; and

said first sloped side sheet meets said first sidewall at said transition portion.

7. The rail road hopper car of claim **6** wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said first sloped side sheet meets said transition portion at an height that is in the range of ¼ to ⅔ L above said first side sill.

8. The rail road hopper car of claim **2** wherein said hopper has a cross-wise extending outboard end top chord; and an end post extends from said draft sill to said end top chord, said end post being mounted above said draft sill between said truck center and said striker.

9. The rail road hopper car of claim **8** wherein:

said hopper has an end wall extending downward of said end top chord;

said upper, longitudinally outboard end of said first end slope sheet meets said downwardly extending end wall; and

said first cross-wise extending beam is located where said downwardly extending end wall meets said first end slope sheet; and

said first cross-wise extending beam is of hollow cross-section.

10. The rail road hopper car of claim **8** wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

11. The rail road hopper car of claim **10** wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.

12. The rail road hopper car of claim **2** wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.

13. The rail road hopper car of claim **12** wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

14. The rail road hopper car of claim **2** wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

15. The rail road hopper car of claim **2** wherein said first and second portions of said sidewall stiffener are made of flat bar, are positioned in vertical-transverse planes, are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

* * * * *

EXHIBIT A1-2

US008132515B2

(12) **United States Patent**
Forbes et al.

(10) **Patent No.: US 8,132,515 B2**
(45) **Date of Patent: Mar. 13, 2012**

(54) **RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR**

(75) Inventors: **James W. Forbes**, Campbellville (CA); **Marcus Thiesen**, Hamilton (CA); **Dave Keats**, Brantford (CA)

(73) Assignee: **National Steel Car Limited** (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/816,660**

(22) Filed: **Jun. 16, 2010**

(65) **Prior Publication Data**

US 2010/0251922 A1 Oct. 7, 2010

Related U.S. Application Data

(62) Division of application No. 12/559,065, filed on Sep. 14, 2009.

(30) **Foreign Application Priority Data**

Sep. 14, 2009 (CA) 2678605

(51) **Int. Cl.**
B61D 17/00 (2006.01)

(52) **U.S. Cl.** **105/406.1**; 105/248; 105/240; 105/247; 105/250

(58) **Field of Classification Search** 105/406.1, 105/406.2, 396, 404, 411, 413, 416, 417, 105/418, 419, 250
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

673,103 A * 4/1901 Williamson et al. 105/248
(Continued)

FOREIGN PATENT DOCUMENTS

CA 1082524 A1 7/2009
(Continued)

OTHER PUBLICATIONS

5 Photographs of Quebec Iron and Titanium (QIT) ore hopper car No. 556, dated Aug. 15, 2007.

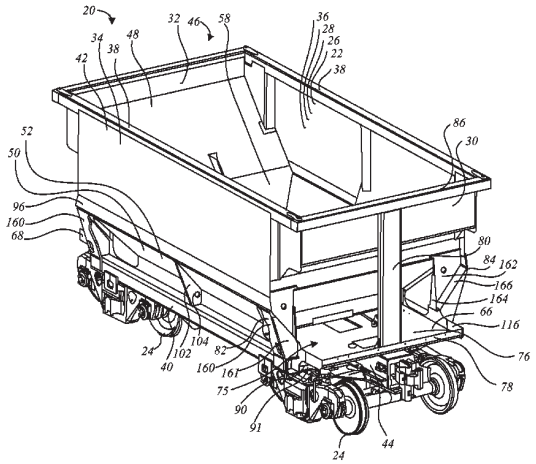
(Continued)

Primary Examiner — Joe Morano, IV
Assistant Examiner — Jason C Smith
(74) *Attorney, Agent, or Firm* — Hahn Loeser & Parks LLP; Michael H. Minns

(57) **ABSTRACT**

A railroad gondola car has a hopper carried between two trucks. The hopper has convergent end and side slope sheets that feed a bottom discharge. The bottom discharge has a pair of longitudinal doors. The door closing mechanism is a mechanical transmission that includes a set of linkages running from the door to a reciprocating pneumatic cylinder. The linkages run generally parallel to the slope sheet. The car has a very short draft installation that includes a removable coupler carrier bar, and the main shear plate has a removable draft gear installation panel. There is a machinery space above the end section shear plate. It is overhung by the slope sheet that is substantially unobstructed by any other primary structure. The pneumatic cylinder is mounted on an angle in this unobstructed machinery space, oriented longitudinally over the draft sill beneath the main drag link of the mechanical transmission, and above the main pivot of the driving input lever of the transmission. The main lever is bifurcated, and straddles the pneumatic cylinder. The mechanism includes a primary lock in the form of an over center lever arrangement, and a compact secondary lock that acts sideways rather than lengthwise. The sidewalls of the car include vertical stiffeners and side sheets. The lower portion of the side sheets lies laterally inboard of the stiffener web, while the upper portion lies laterally outboard of the stiffener web. The side slope sheet of the hopper meets the sidewall at the transition of the sidewall sheet from the inside-the-post to the outside-the-post condition.

44 Claims, 18 Drawing Sheets



U.S. PATENT DOCUMENTS

763,186	A		6/1904	Johnson	
1,421,439	A		7/1922	Finckh	
3,173,381	A		3/1965	Charles et al.	
3,187,684	A		6/1965	Ortner	
3,405,655	A	*	10/1968	Dorey	105/250
3,408,956	A		11/1968	Rebenok et al.	
3,483,830	A		12/1969	McGrath	
3,577,932	A		5/1971	Pulcrano et al.	
3,596,609	A		8/1971	Ortner	
3,611,947	A		10/1971	Nagy	
3,654,873	A		4/1972	Floehr	
3,710,730	A	*	1/1973	Austgen et al.	105/250
3,717,109	A		2/1973	Miller	
3,717,110	A		2/1973	Miller	
3,800,711	A		4/1974	Tuttle	
3,807,316	A		4/1974	Miller	
3,815,514	A		6/1974	Heap	
3,818,842	A		6/1974	Heap	
3,863,986	A		2/1975	Mentessi	
3,872,796	A		3/1975	Alder et al.	
3,878,794	A		4/1975	Adler	
3,931,768	A		1/1976	Price et al.	
3,949,681	A		4/1976	Miller	
3,994,238	A		11/1976	Adler	
4,106,813	A		8/1978	Goodbary	
4,120,409	A		10/1978	vander Werff	
4,194,450	A		3/1980	Miller	
4,222,334	A		9/1980	Peterson	
4,224,877	A	*	9/1980	Stark et al.	105/250
4,232,989	A		11/1980	Miller	
4,246,849	A	*	1/1981	Gramse	105/251
4,250,814	A		2/1981	Stark et al.	
4,252,068	A		2/1981	Nolan	
4,348,962	A	*	9/1982	Smith	105/248
4,361,097	A	*	11/1982	Jones et al.	105/406.1
4,484,527	A	*	11/1984	O'Hara	105/247
4,542,701	A		9/1985	Fischer et al.	
4,555,033	A		11/1985	Miller	
RE32,189	E	*	6/1986	Adler et al.	105/377.07
4,601,244	A		7/1986	Fischer	
4,637,320	A	*	1/1987	Paton et al.	105/406.1
4,740,130	A		4/1988	Prins	
4,800,820	A	*	1/1989	Tomaka	105/406.1
4,843,974	A		7/1989	Ritter et al.	
4,884,511	A		12/1989	Hallam et al.	
4,893,568	A	*	1/1990	Adams	105/416
4,898,101	A	*	2/1990	Harter	105/247
5,063,858	A		11/1991	Dugge	
5,086,709	A		2/1992	Fischer et al.	
5,144,895	A		9/1992	Murray	
5,163,372	A		11/1992	Galvan et al.	
5,181,474	A	*	1/1993	Miller	105/355
5,249,531	A		10/1993	Taylor	
5,261,333	A		11/1993	Miller	
5,813,353	A	*	9/1998	Sauter	105/406.1
5,823,118	A		10/1998	Manstrom	
6,604,469	B1		8/2003	Galvan et al.	
6,745,701	B2		6/2004	Elder	
7,080,598	B2	*	7/2006	Creighton et al.	105/247
7,367,272	B2		5/2008	Taylor	
7,681,507	B2	*	3/2010	Herzog et al.	105/286
7,735,426	B2	*	6/2010	Creighton et al.	105/286
7,780,021	B2		8/2010	Forbes	
2010/0251922	A1	*	10/2010	Forbes et al.	105/240

FOREIGN PATENT DOCUMENTS

CN	101486347		7/2009
EP	0543279	B1	5/1995
EP	1790547	A1	5/2007
EP	1798103	A1	6/2007
GB	1318571		5/1973
GB	2013598		8/1979

OTHER PUBLICATIONS

Drawing of QIT car dated Aug. 27, 2007.

2 Sheets of Details of End Structure of an Admitted Prior Art Grain Car of National Steel Car Showing End Post, Lateral Intermediate Stub Wall, Elephant Ears Arrangement and End Slope Sheet to Shear Plate Connection at least as early as Jan. 1, 2001.

Reproduction of Design Drawing of Dulth, Missabi & Iron Range (DM&IR) Open Topped Ore Hopper Car General Arrangement Drawing 8760 Drawn Apr. 8, 1950, (Quality Poor in Original), Showing Rear Draft Stops Extending Inboard of Truck Center.

Freight Cars: Hopper, Ore; Car Builders' Cyclopedia, 1937, pp. 313-320, 14th ed., Simmons-Boardman Publishing Corporation, New York, NY.

A.C.F. Covered and Open Top Hopper Cars; Car Builders' Cyclopedia, 1943, pp. 281-289, 16th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1957, pp. 265-272, 20th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1961, pp. 246-258, 21st ed., Simmons-Boardman Publishing Corporation, New York, NY.

Car and Locomotive Cyclopedia, 1966, 10 pp., 1st ed., Simmons-Boardman Publishing Corporation, New York, Ny.

* cited by examiner

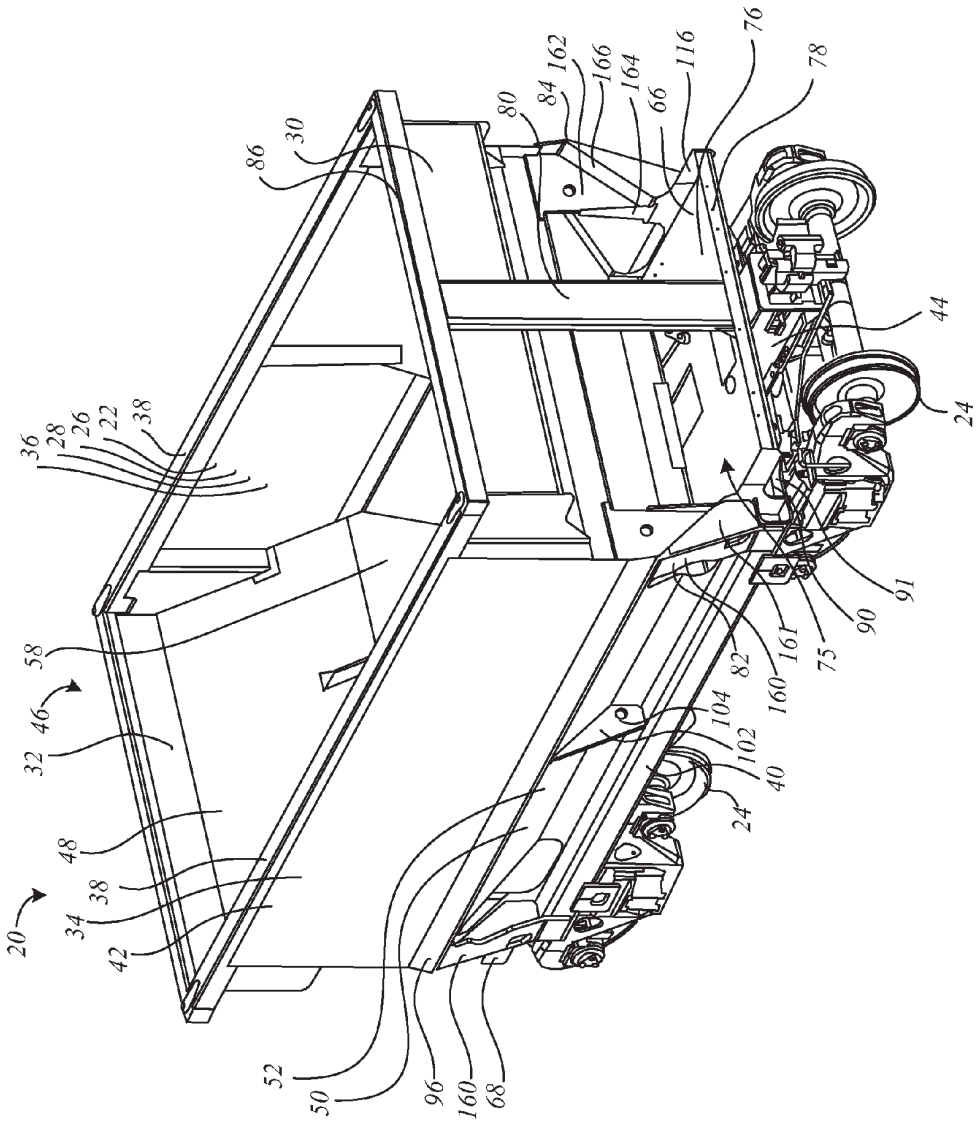

76
116
166
162
84
80
78
66
164
86
30
44
24
36
28
26
22
38
58
46
32
48
38
34
20
42
52
50
96
160
68
91
90
75
161
160
82
104
102
40
24

Figure 1

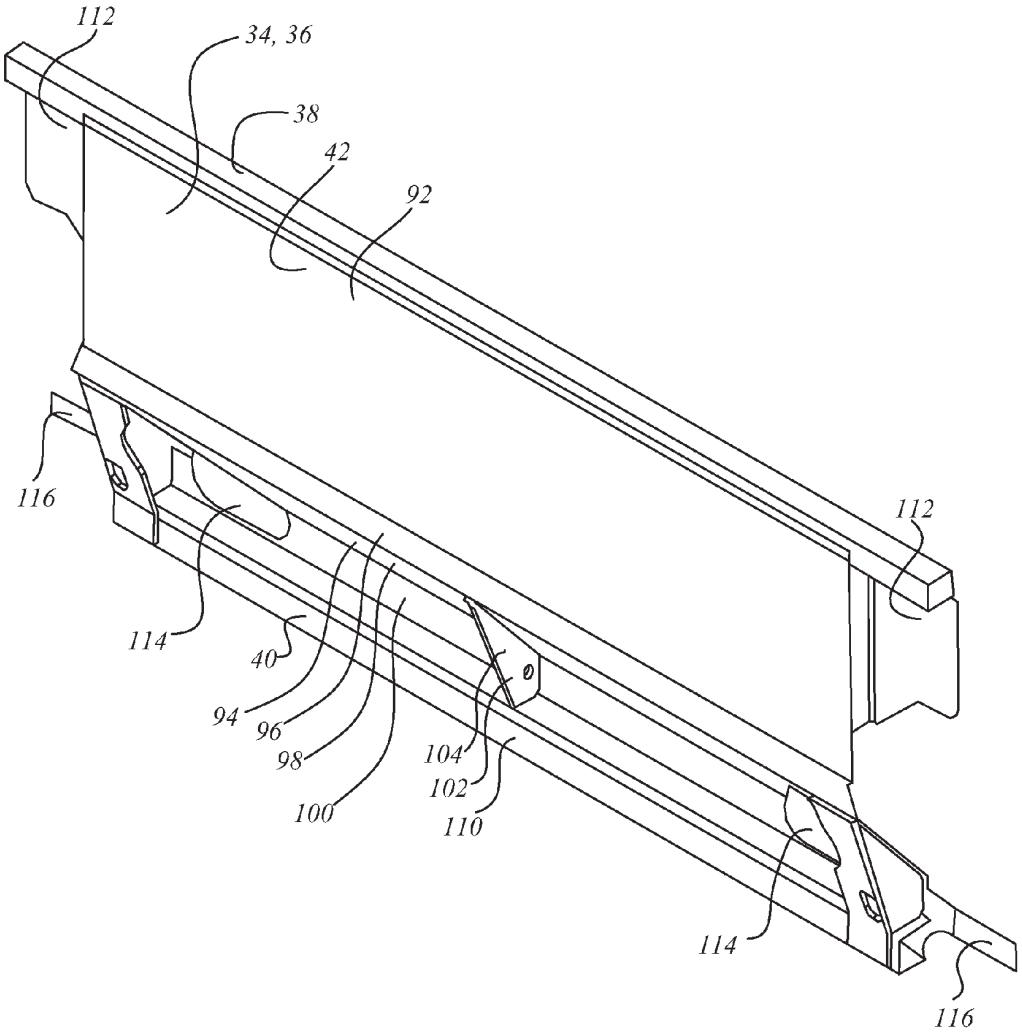


Figure 2a

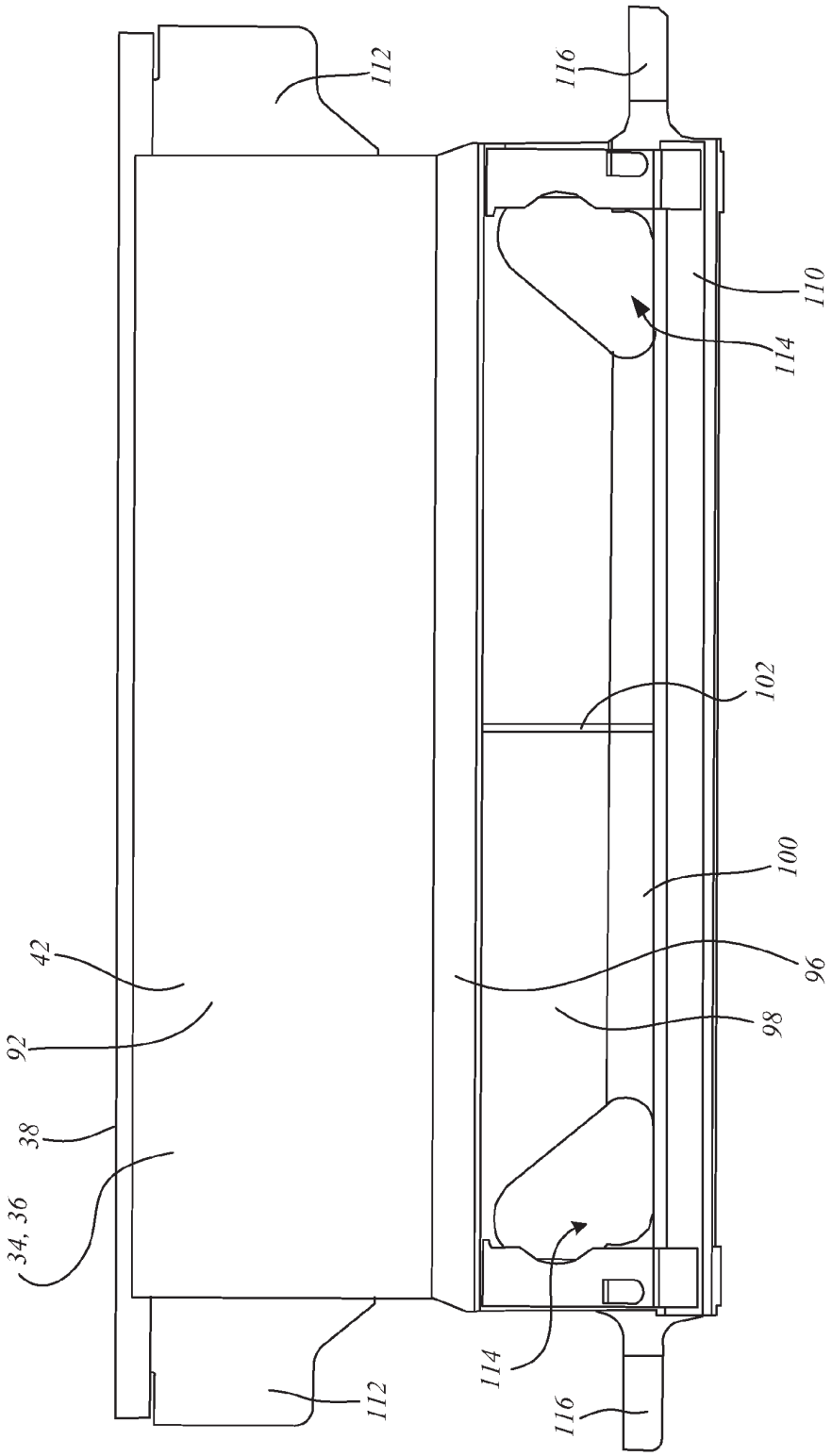


Figure 2b

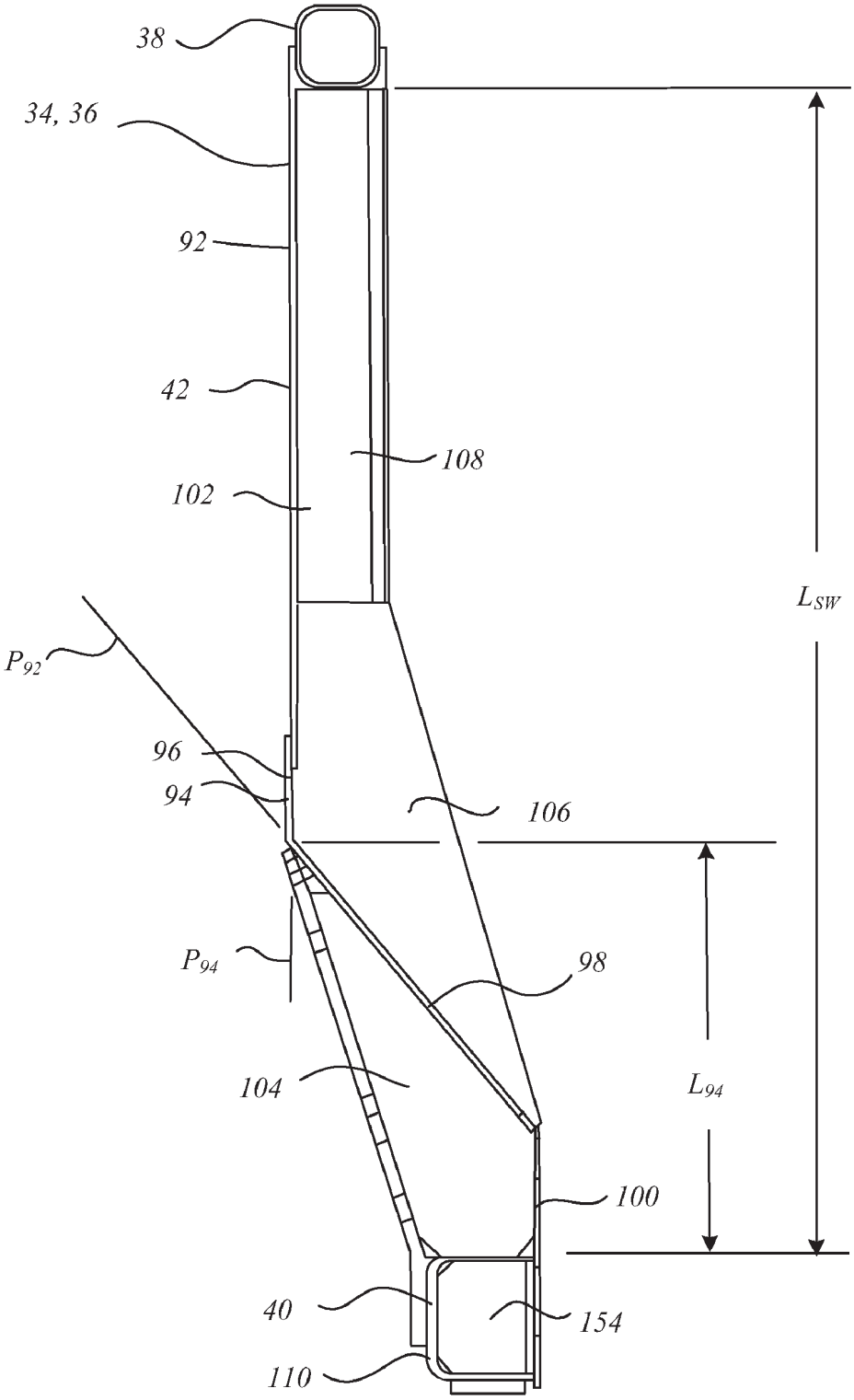

38
34, 36
92
42
108
102
L_{SW}
P_{92}
96
94
106
P_{94}
98
104
L_{94}
100
40
154
110

Figure 2c

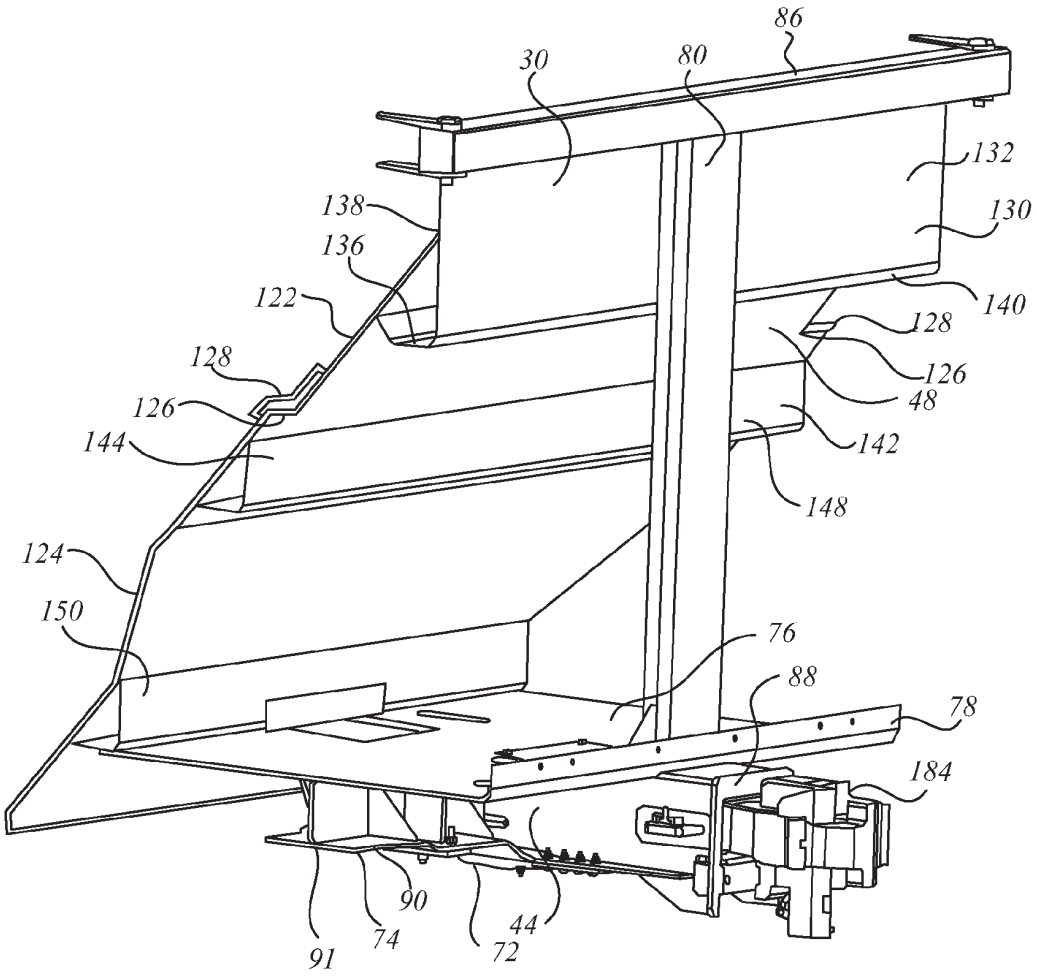

86
30
80
132
130
138
136
140
122
128
128
126
48
126
144
142
148
124
150
76
88
78
184
90
44
74
72
91

Figure 3a

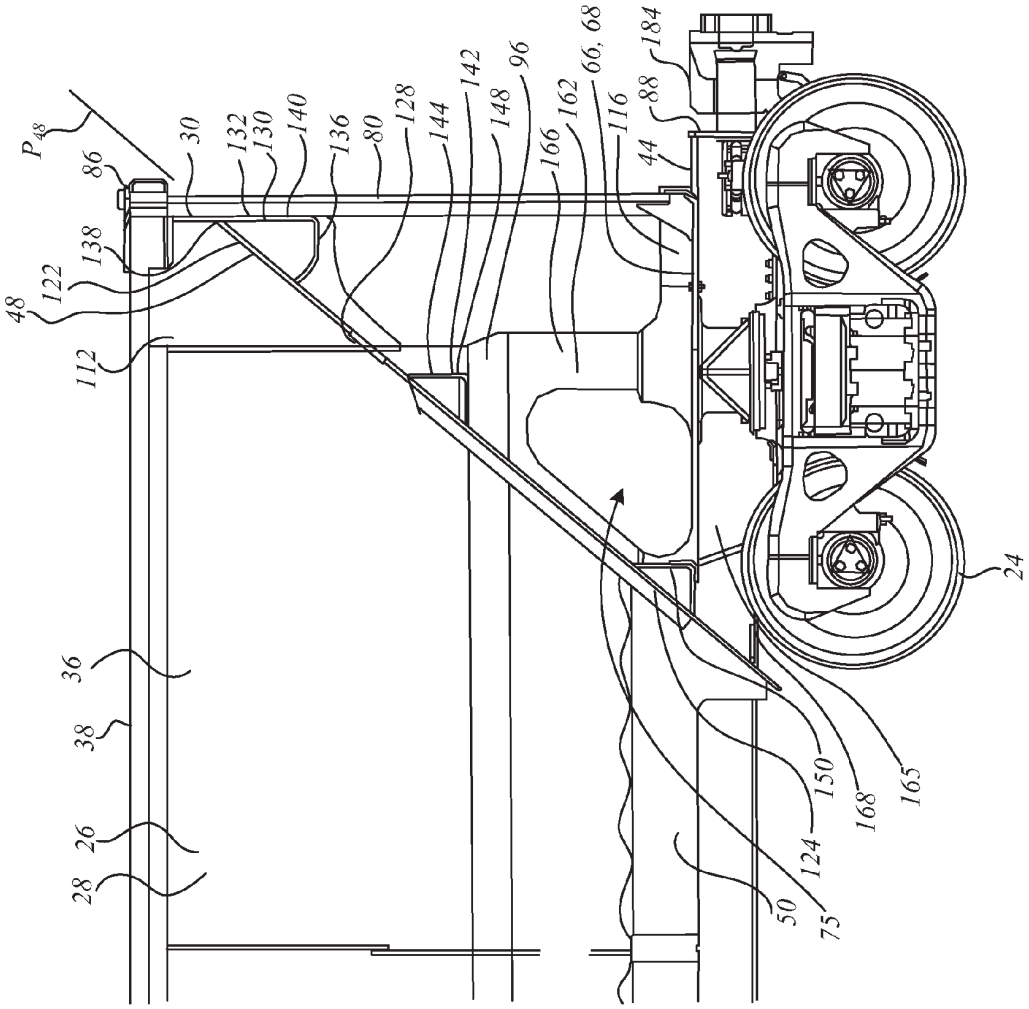

P_{48}
30
132
130
140
136
80
128
144
142
148
96
166
162
66, 68
116
88
184
44
86
138
122
48
112
36
38
26
28
24
150
168
165
124
50
75

Figure 3b

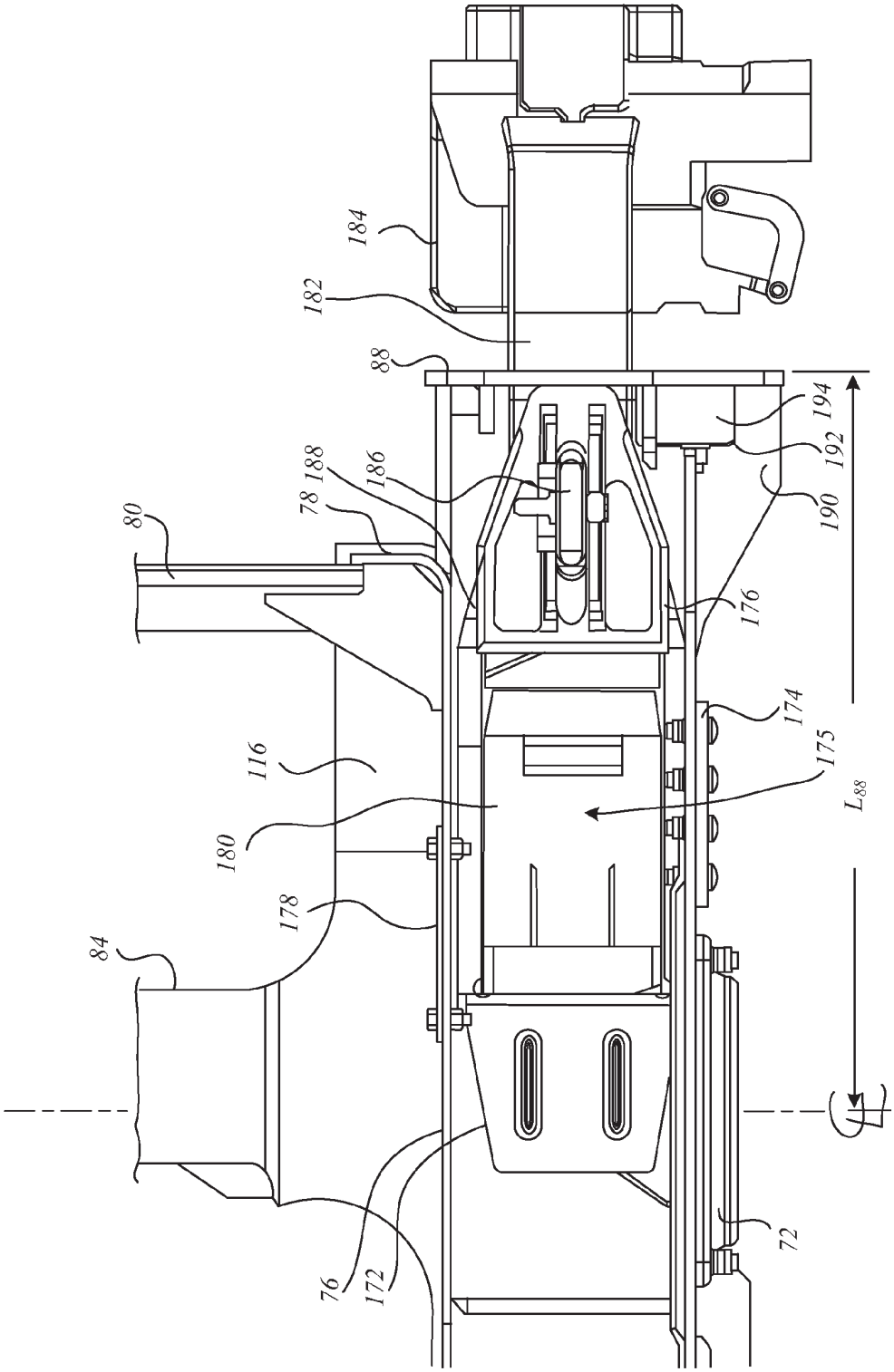

184
182
88
194
192
190
188
186
78
80
176
174
175
116
180
178
84
L_{88}
72
76
172

Figure 3c

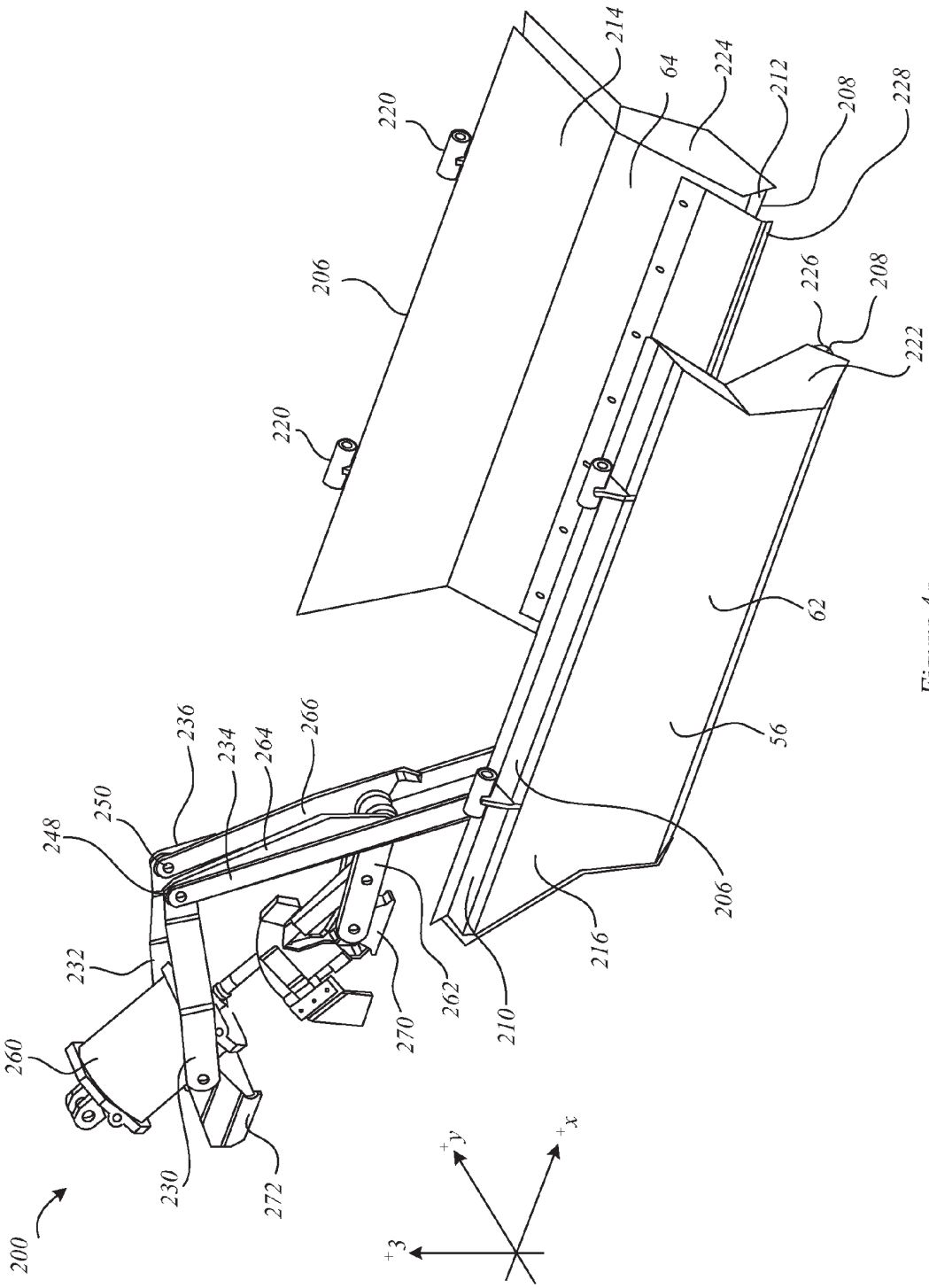

214
64
224
212
208
228
220
206
226
208
222
220
62
56
206
216
210
262
270
232
260
230
272
200
+y
+x
+3

Figure 4a

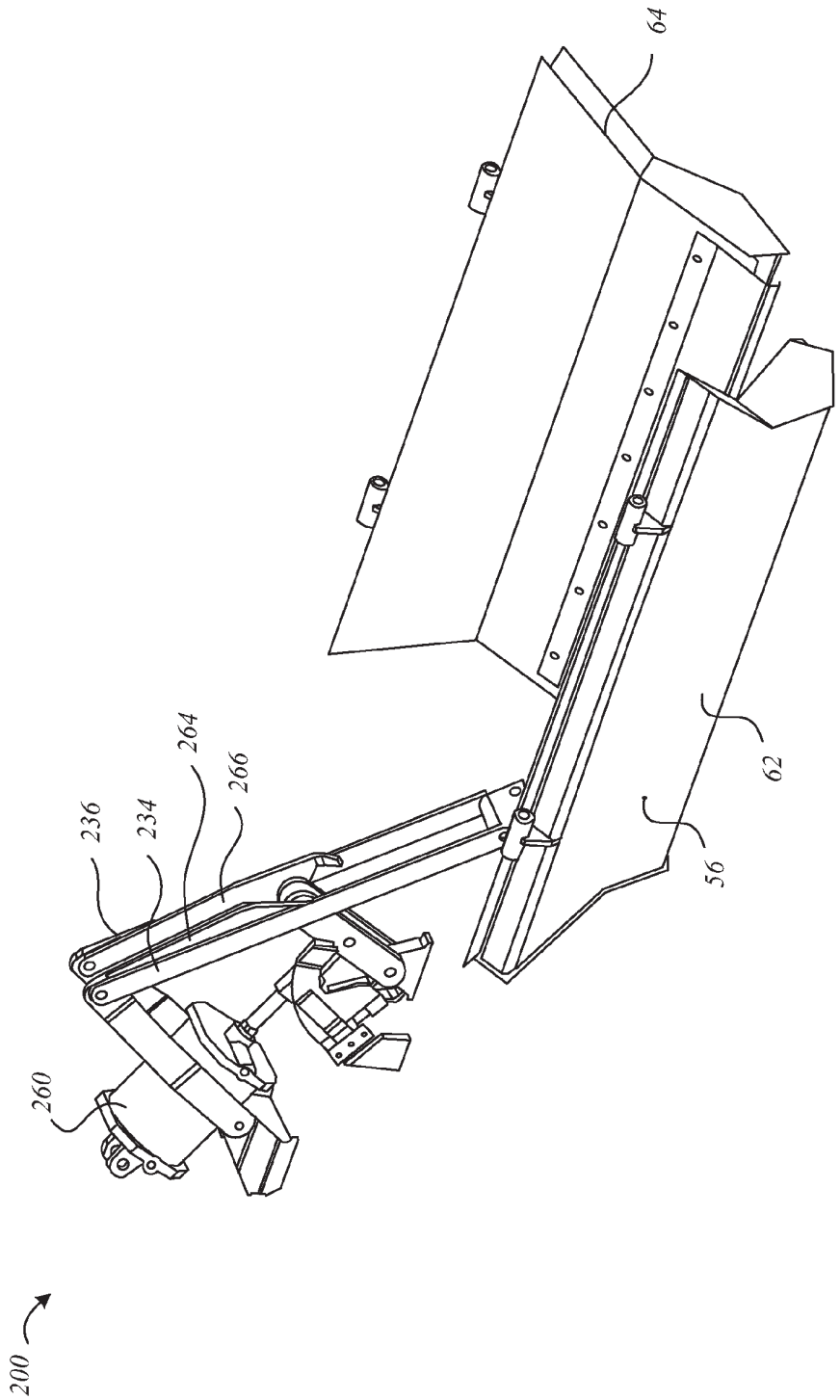


Figure 4b

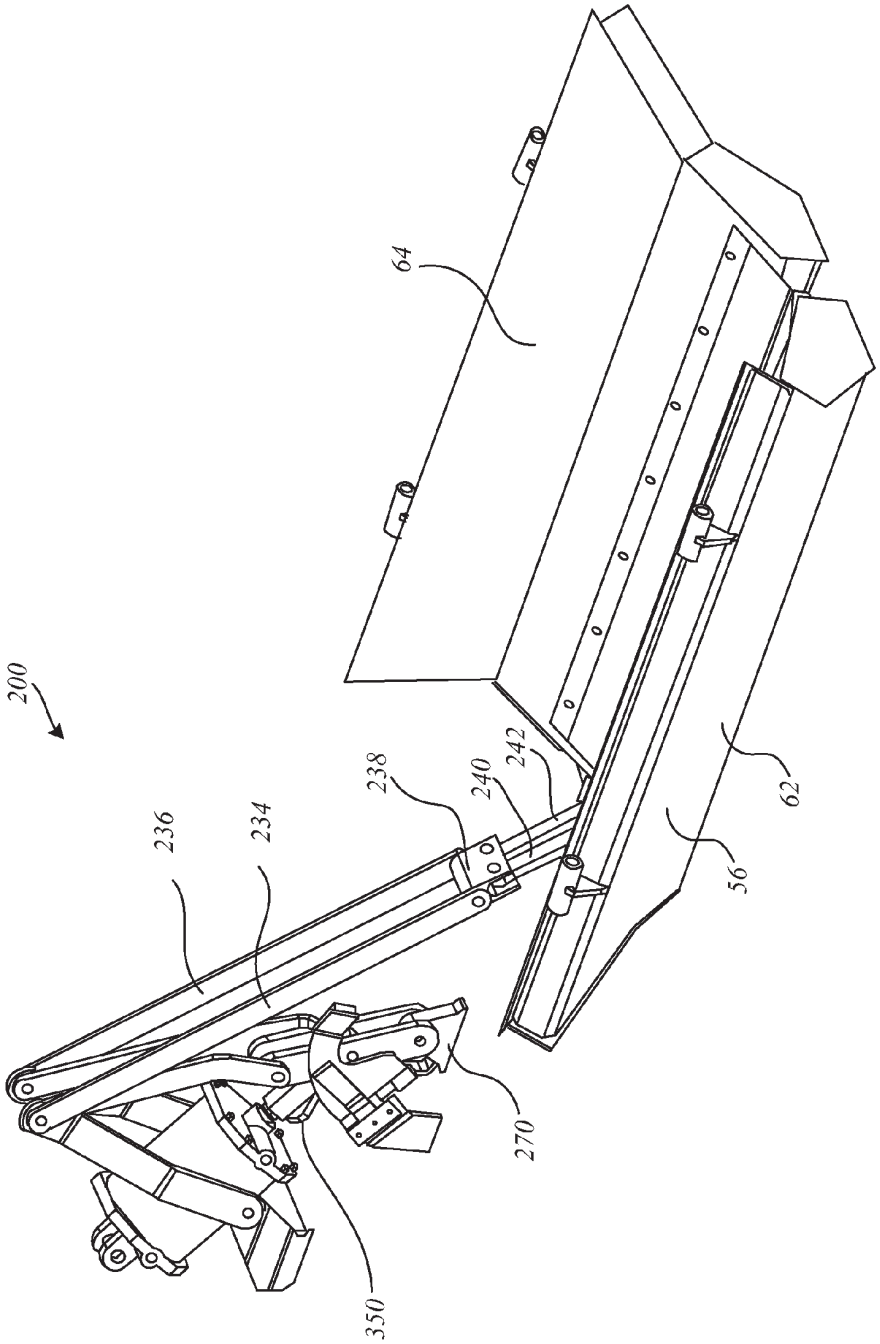


Figure 4c

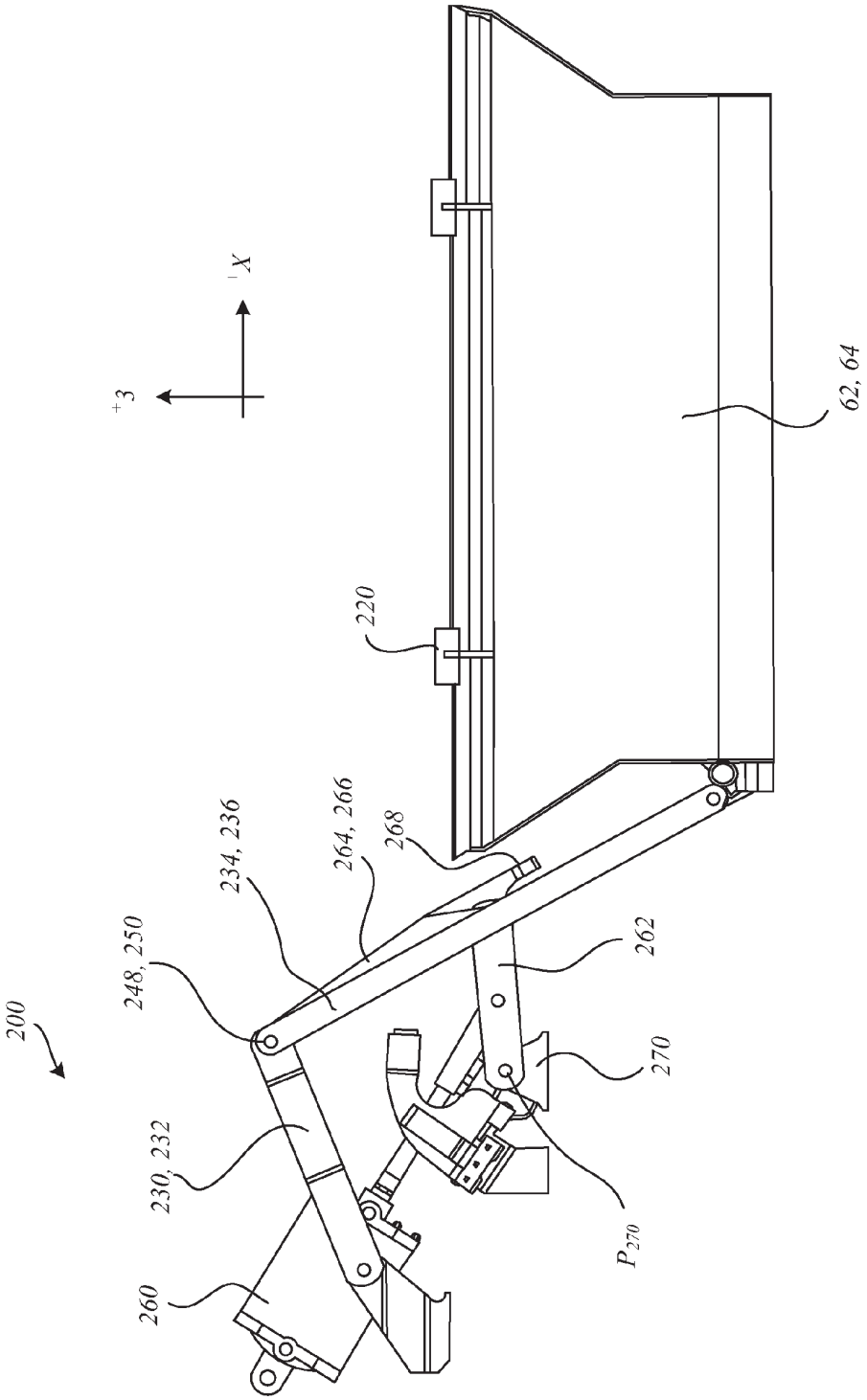

+X
+3
62, 64
220
264, 266
268
234, 236
248, 250
262
270
200
230, 232
260
P_{270}

Figure 5a

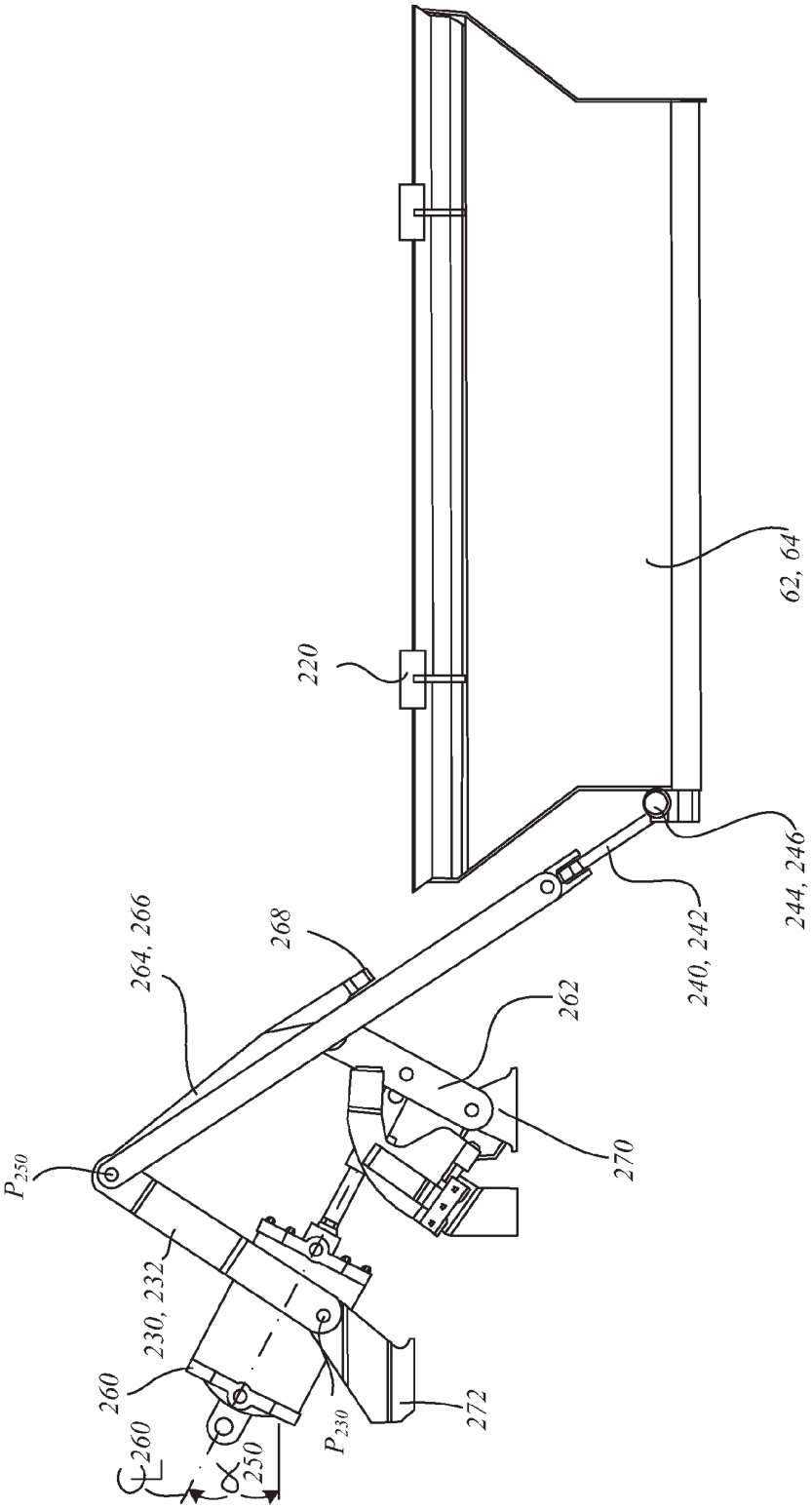

220
62, 64
244, 246
240, 242
268
264, 266
262
270
P_{250}
230, 232
260
260
250
P_{230}
272

Figure 5b

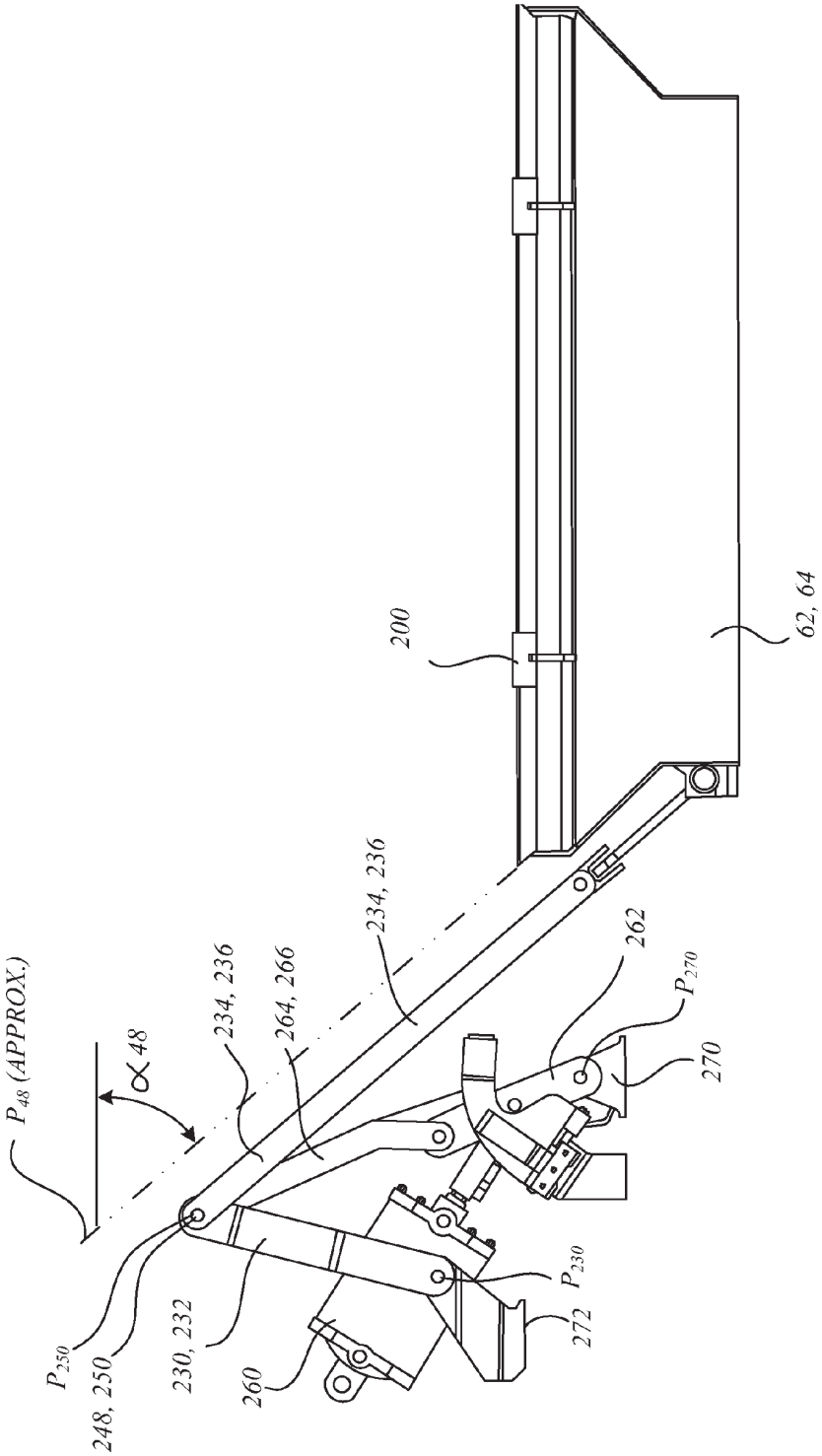

200
62, 64
234, 236
262
P_{270}
270
P_{48} (APPROX.)
α 48
234, 236
264, 266
P_{230}
272
P_{250}
248, 250
230, 232
260

Figure 5c

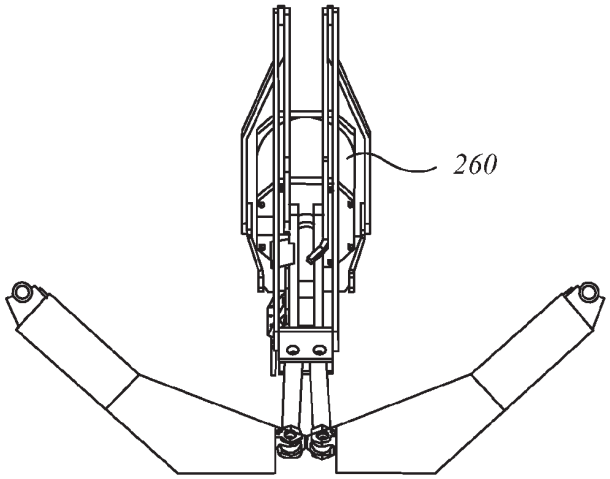


Figure 6c

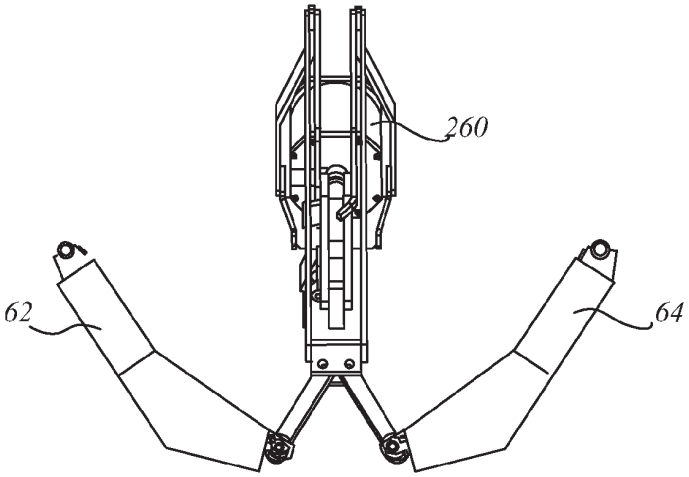


Figure 6b

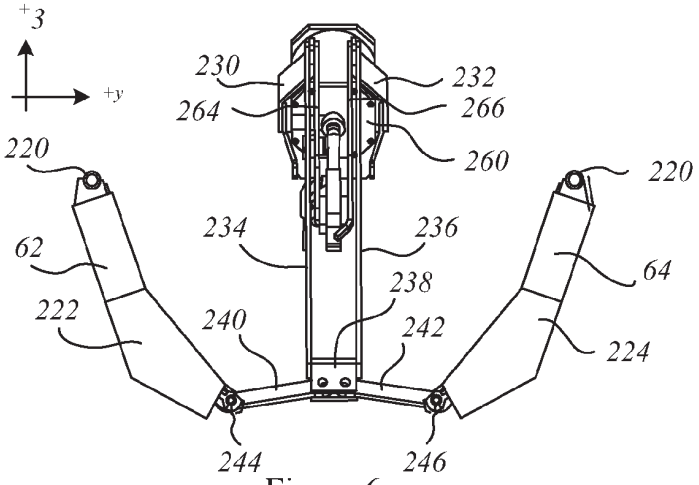


Figure 6a

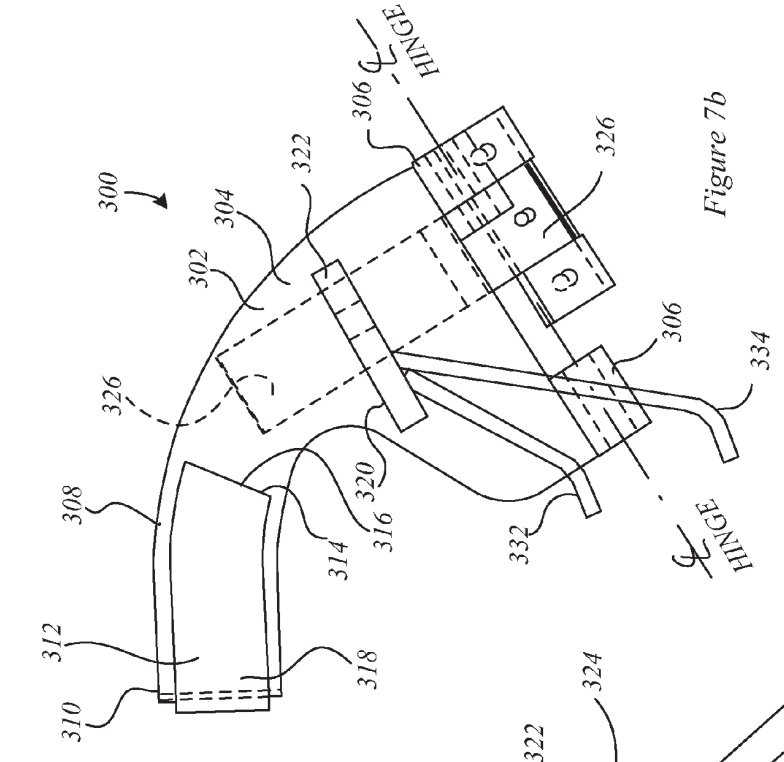


Figure 7b

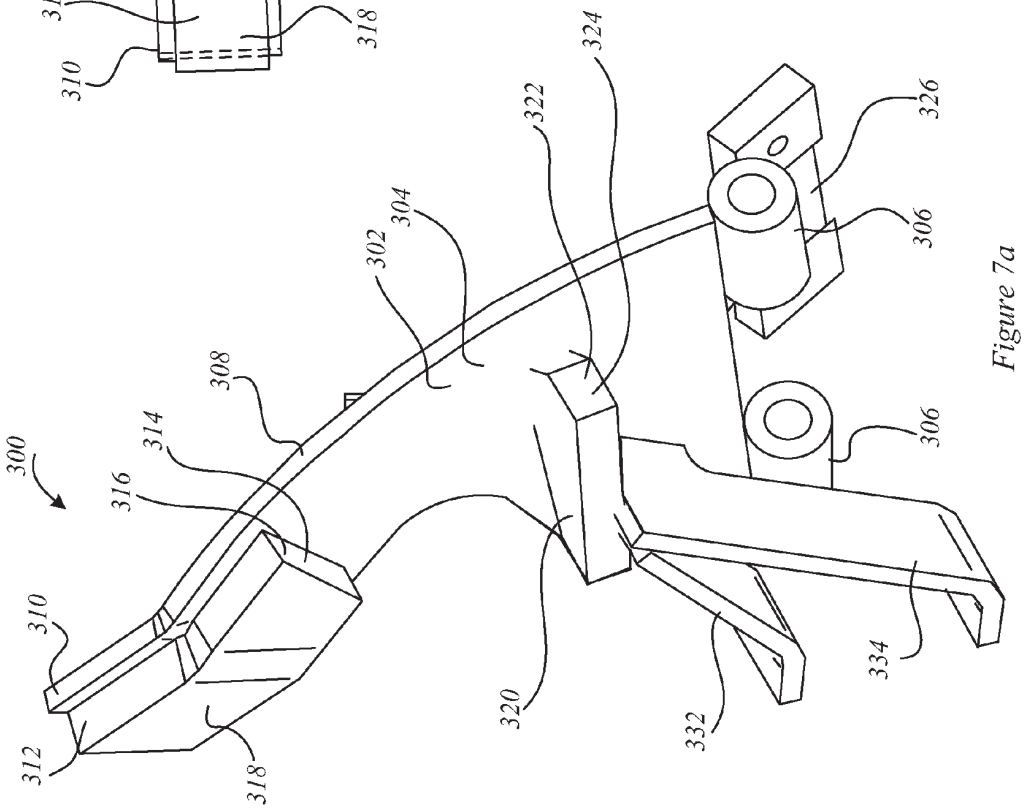


Figure 7a

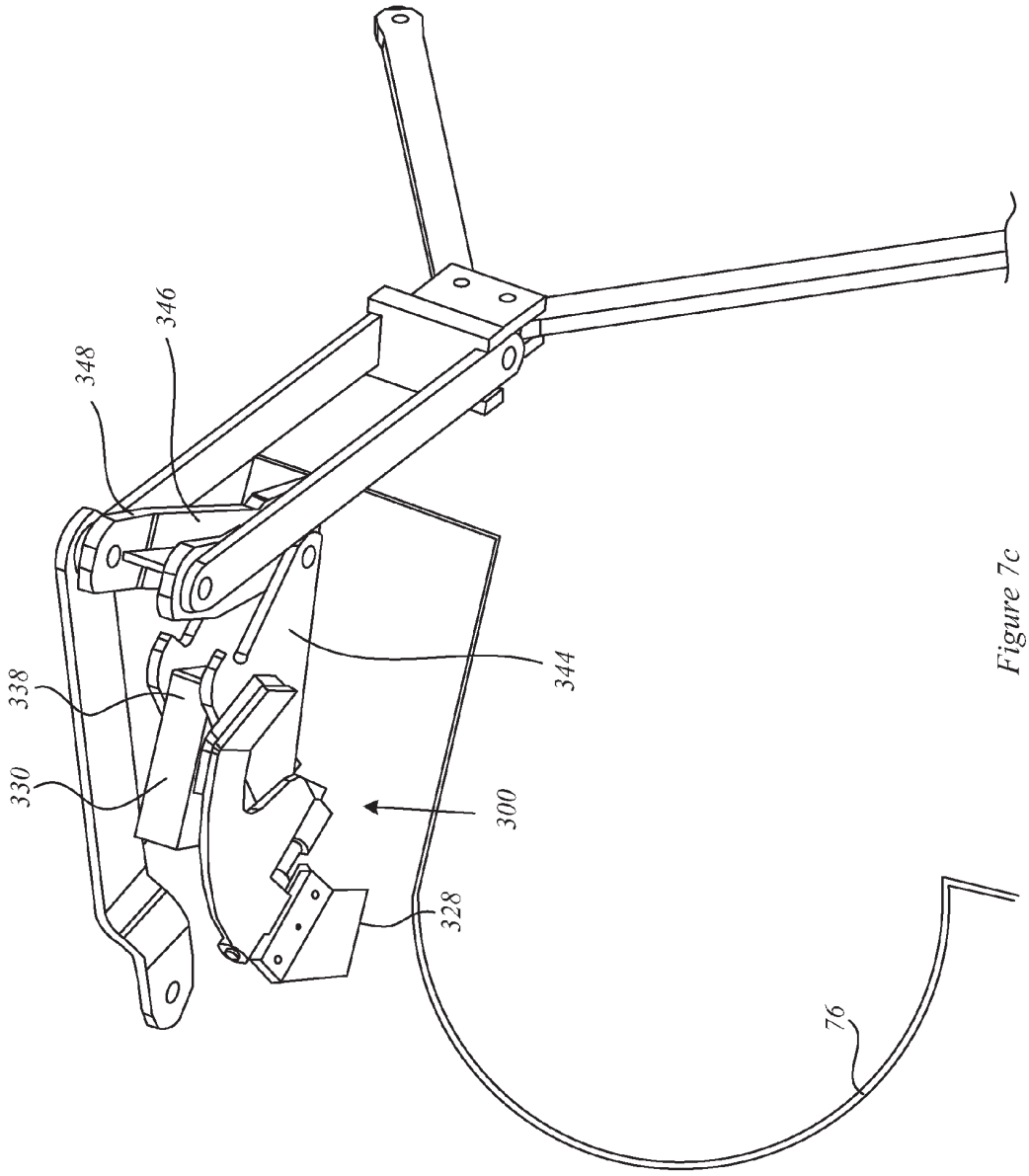


Figure 7c

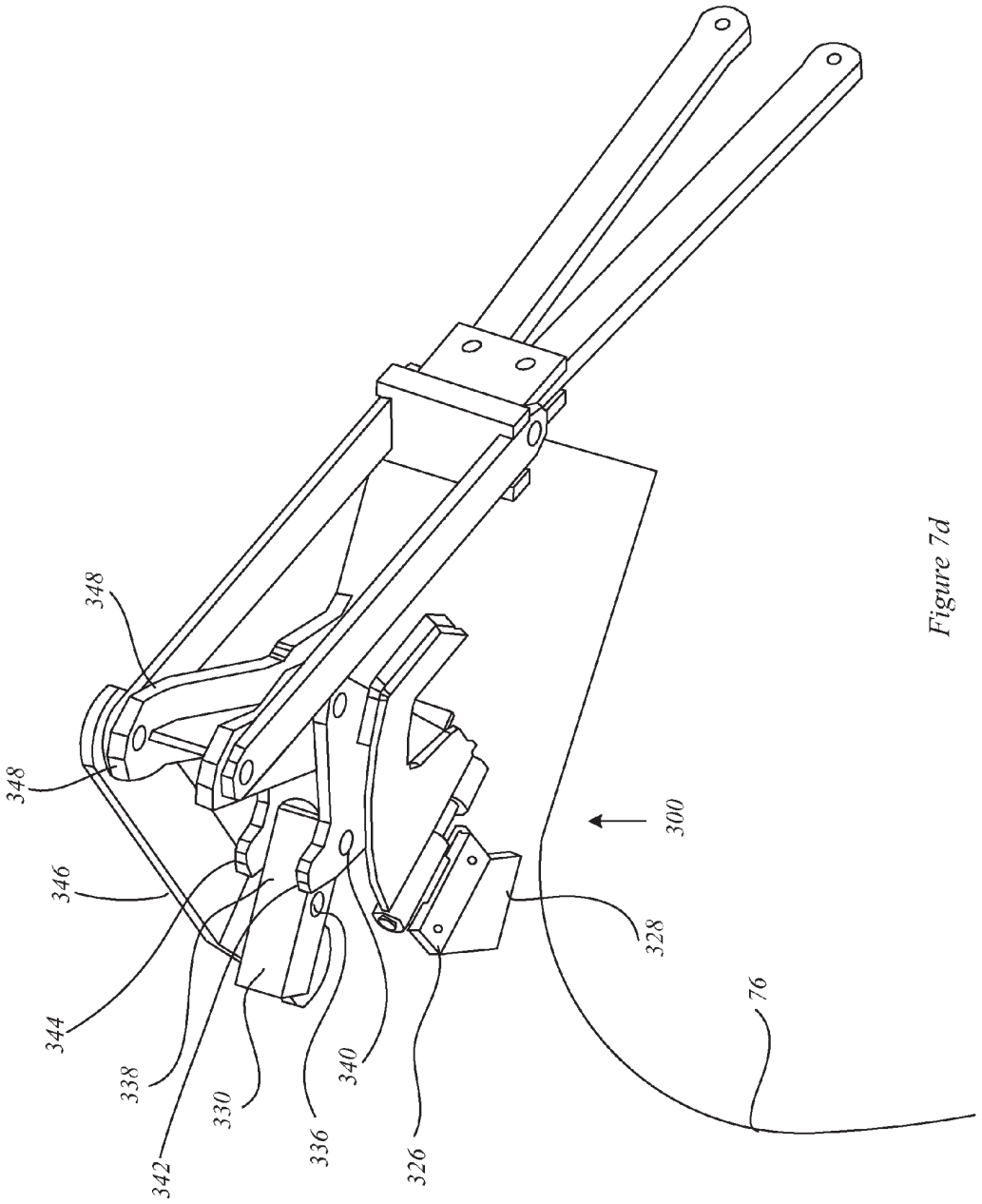


Figure 7d

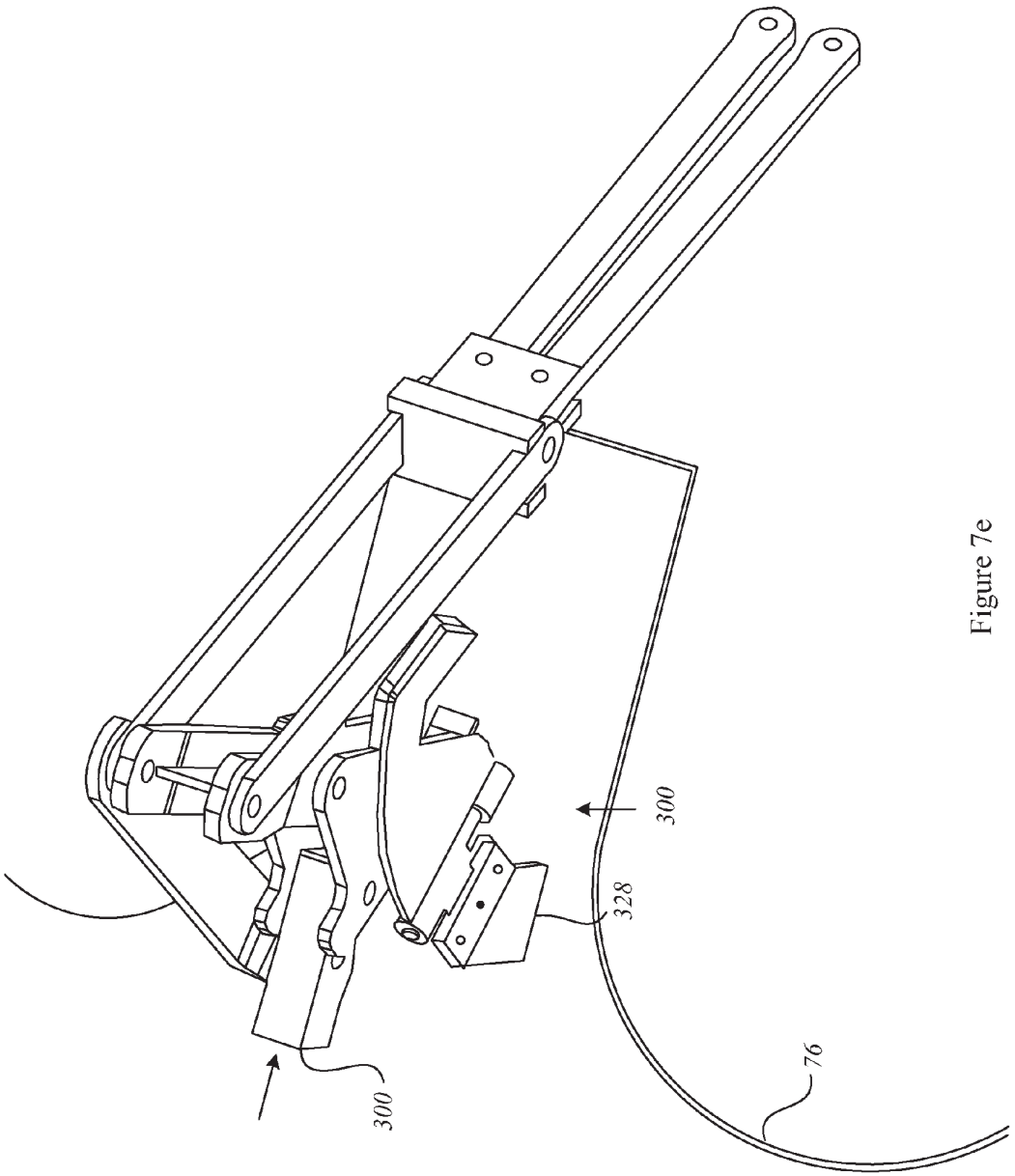


Figure 7e

RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR

This application is a divisional application of U.S. patent application Ser. No. 12/559,065 entitled "Railroad Gondola Car Structure and Mechanism Therefor," filed Sep. 14, 2009, which claims priority under 35 USC 119 to Canadian Patent Application Serial Number 2,678,447, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 11, 2009, and Canadian Patent Application Serial Number 2,678,605, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 14, 2009. U.S. patent application Ser. No. 12/559,065 is incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to the field of railroad freight cars, and, in particular to rail road gondola cars such as may employ bottom unloading gates or doors.

BACKGROUND

There are many kinds of rail road cars for carrying particulate material, be it sand or gravel aggregate, plastic pellets, grains, ores, potash, coal or other granular materials. Many of those cars have an upper opening, or accessway of some kind, by which the particulate is loaded, and a lower opening, or accessway, or gate, or door by which the particulate material exits the car under the influence of gravity. While the inlet opening need not necessarily have a movable gate, the outlet opening requires a governor of some kind that is movable between a closed position for retaining the lading while the lading is being transported, and an open position for releasing the lading at the destination. The terminology "flow through" or "flow through rail road car" or "center flow" car, or the like, may sometimes be used for cars of this nature where lading, typically particulate lading, is introduced at the top, and flows out at the bottom.

Discharge doors for gondola cars or other bottom dumping cars may tend to have certain desirable properties. First, to the extent possible it is usually desirable for the door opening to be large so that unloading may tend to be relatively fast, and for the sides of any unloading chute to be relatively steep so that the particulate will tend not to hang up on the slope. Further, to the extent that the door can be large and the slope sheets steep, the interior of the car may tend to have a greater lading volume for a given car length. Further still, any increase in lading achieved will tend to be at a relatively low height relative to Top of Rail (TOR) and so may tend to aid in maintaining a low center of gravity. A low center of gravity tends to yield a better riding car that is less prone to derailment, and perhaps less prone to cause as much wear or damage to tracks.

For a given length of car, hopper volume, and hence overall car volume, can be maximized by reducing the proportion of the length of the car occupied by the trucks, and occupied by the door opening drive mechanism. Furthermore, where the lading to be carried by the car is of greater than usual density, it may often be helpful for the truck center length to be relatively short such that the length of the span between the trucks is smaller, and the weight of the structure may be correspondingly decreased relative to the maximum permissible gross weight on rail for the car. In some instances, as with iron ore or other high density lading, that truck center distance may be very short.

It may also be that in some circumstances ore cars are used in quasi-permanent sets that form a unit train. The unit train may tend to follow a single route for substantially its entire operational service life. In the case of an ore car, that operational route may be from a mine or concentrator facility, at which the cars receive the lading; to a discharge facility, whether a mill or a break of bulk terminal at a port. In these circumstances the line may be owned by the mine or mill, and the cars may not necessarily be used for interchange service. To the extent that they are not used for interchange service they may not necessarily comply with all AAR standards. The cars may have short, possibly non-standard draft sills, draft gear, and couplers, or a combination thereof.

The cars may have tightly limited space envelopes over the end shear plates, and yet these spaces may nonetheless be intended to accommodate, for example, the brake reservoir and pneumatic gear for operating the gondola discharge doors.

SUMMARY OF THE INVENTION

In an aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a door movable between a closed position for retaining lading and an open position for permitting egress of lading. The hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has at least a first end slope sheet inclined downwardly in the lengthwise direction toward the door. There is a linkage connected to the door. The linkage is oriented lengthwise with respect to the car. A drive is connected to the linkage. The drive is operable to move the linkage and thereby to urge the door to a closed position. The linkage is movable from a first position corresponding to the open position of the door to a second position corresponding to the closed position of the door. The linkage includes at least a drag link. When the linkage moves from the first to the second position one of (a) the overall motion from the first to the second position includes displacement of the drag link in a direction having a predominant component of motion parallel to the first end slope sheet; and (b) the motion of the drag link is at least instantaneously parallel to the first end slope sheet.

In another feature of that aspect of the invention the linkage includes a first pivot arm pivotally connected to a datum structure at a first pivot connection. The drive is also mounted to the datum structure. The linkage includes a second pivot arm pivotally connected to the datum structure at a second pivot connection. The second pivot arm has the door mounted thereto. The first pivot arm has a second connection distant from the first pivot connection. The second pivot arm has a second connection distant from the second pivot connection. A mechanical transmission is mounted between the second connection of the second pivot arm and the second connection of the first pivot arm. The mechanical transmission includes the drag link. The drive is connected to move the first pivot arm, and, in moving from the first position to the second position, each position of the first pivot arm being associated with a unique position of the drag link. In a further feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand

door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. Each second pivot arm has a respective second connection distant from the respective second pivot connection. A mechanical transmission is mounted between the respective second connections of the second pivot arms and the respective second connections of the first pivot arms. The drag link is a left hand drag link, and the mechanical transmission includes a mated parallel right hand drag link. The left and right hand drag links each have a first end mounted to one of the respective second connections of the first pivot arms. The left and right hand drag links have second ends yoked together distantly from the first ends. The transmission member includes left and right hand slave links extending between and connecting the second ends of the drag links to the second connections of the second pivot arms respectively.

In still another feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. The left and right hand pivot arms co-operate to define a bifurcated lever straddling the drive. In yet another feature, the drive includes an actuating cylinder having an axially reciprocating member, the axially reciprocating member being inclined relative to horizontal. In still another feature the drag link lies between the actuating cylinder and the first end slope sheet of the hopper. In another feature the railroad hopper car includes a first end section, the first end section includes a draft sill and a substantially horizontal shear plate mounted over the draft sill, the drive includes an actuating cylinder having an axis of reciprocation lying in a central vertical-lengthwise plane of the car, the actuating cylinder is mounted above the shear plate, the first end slope sheet at least partially overhangs the actuating cylinder; and the drag link is located between the actuating cylinder and the first slope sheet.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. The car includes structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. A door operating linkage is connected to the gate, the door operating linkage being oriented lengthwise with respect to the car. An actuating cylinder connected to drive the door operating linkage, the actuating cylinder also being oriented to act lengthwise with respect to the car, the actuating cylinder having an axis of reciprocation. The axis of reciprocation being tilted such that displacement of the actuating cylinder includes a vertical component of motion.

In another feature of that aspect of the invention, the hopper car includes an end section mounted over one of the trucks, the end section includes a substantially horizontal shear plate, and the actuating cylinder is mounted on a pedestal mounted to the shear plate, the pedestal including an inclined mounting for the cylinder. In a further feature, the railroad hopper car has a longitudinal-vertical central plane, and the axis or reciprocation lies in the longitudinal-vertical plane. In a still further feature, the hopper includes at least a first end slope sheet extending longitudinally and being inclined longitudinally inboard and downwardly toward the gate, and at least part of the actuating cylinder is overhung by at least part of the first end slope sheet. In a yet further feature, the hopper car includes an end section having a substantially horizontal shear plate mounted over a draft sill. The hopper includes a first end slope sheet, the first end slope sheet at least partially overhanging the horizontal shear plate. The actuating cylinder is mounted above the shear plate, centrally aligned over the draft sill. The actuating cylinder is at least partially overhung by the first end slope sheet. In still yet another further feature the first slope sheet is substantially planar and has a first angle of inclination relative to horizontal. The actuating cylinder is inclined longitudinally inboard downwardly, and is inclined at a second angle. The second angle lies between horizontal and the first angle. In yet another feature the car has an underframe and the door operating linkage includes a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, the first pivot linkage being a first pivot arm constrained to pivot on an axis of rotation oriented horizontally cross-wise relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and includes at least the gate. The third linkage component includes a drag link element connected to the first pivot arm, the drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator. In still another feature the main pivot connection of the first pivot arm to the first linkage component is located lower than the actuating cylinder. In yet still another feature, the drag link element is connected to the first pivot arm at a distal pivot connection relative to the main pivot connection, and, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection.

In another aspect there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. It has first and second end sections to which the hopper is mounted, the first and second end sections being mounted to respective first and second railroad car trucks for rolling motion along railroad tracks in a lengthwise direction of the car. There is a door operating linkage connected to the gate, the door operating linkage being oriented lengthwise with respect to the car and connected. An actuating cylinder is connected to drive the door operating linkage. The actuating cylinder is also oriented to act in a lengthwise extending plane with respect to the car. The actuating cylinder has an axis of reciprocation. The door operating linkage includes a first pivot arm pivotally mounted to the first end section at a first pivot connection. There is a mechanical transmission connected between the first pivot arm and the gate. The mechanical transmission includes at least a drag link movably connected to the first pivot arm at a location distant from the first

pivot connection. The first pivot connection is lower than the actuating cylinder as seen when viewing the first end section in side view.

In another feature of that aspect of the invention, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection. In still another feature, the actuating cylinder drives an intermediate lever that is connected to drive the first pivot arm.

In another aspect of the invention there is a rail road hopper car. It has a hopper carried between a pair of trucks, the hopper having first and second upstanding sidewalls running lengthwise therealong. The hopper has a lower discharge and convergent slope sheets giving onto the discharge. The rail road car has a side sill and a top chord. The first upstanding sidewall extends from the side sill to the top chord. The first upstanding sidewall has a predominantly upwardly running sidewall stiffener mounted thereto. The sidewall stiffener is located at a longitudinal station intermediate the trucks. The first upstanding sidewall has a first region, the first region being a lower region thereof. The first upstanding sidewall has a second region. The second region is an upper region thereof. The sidewall stiffener has a first portion, the first portion being a lower portion thereof. The first portion is mounted to the first region of the first upstanding sidewall. The sidewall stiffener has a second portion, the second portion being an upper portion thereof. The second portion is mounted to the second region of the upstanding sidewall. The first portion of the first upstanding sidewall stiffener is laterally outboard of the first region of the first upstanding sidewall. The second portion of the sidewall stiffener is laterally inboard of the second region of the first upstanding sidewall. The sidewall has a continuous section between the first and second regions thereof. The sidewall stiffener has web continuity between the first and second portions thereof.

In a feature of that aspect of the invention, the first and second portions of the sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and the stiffener has vertical web continuity through the transition portion. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof. The hopper includes first and second sloped side sheets. The first sloped side sheet meets the first sidewall at the transition portion. In another feature, the first sidewall has an overall height from the side sill to the top chord, L, and the transition is located a distance above the side sill that is in the range of ¼ to ⅔ L. In a still further feature the first sidewall has an overall height from the side sill to the top chord, L, and the first slope sheet meets the transition at an height that is in the range of ¼ to ⅔ L above the side sill.

In a further aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge having a bottom discharge governor movable between a closed position for retaining lading and an open position for permitting egress of lading. The car has structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has a door operating linkage oriented lengthwise with respect to the car. There is an actuating cylinder also oriented to act in a lengthwise extending plane with respect to the car, the actuating cylinder being connected to drive the door operating linkage. The door operating linkage includes a pair of first and second linkage members co-operably mounted to either transverse side of the actuating cylinder, whereby the actuating cylinder is bracketed by the linkage members.

In another feature of that aspect of the invention, the car has an underframe and the linkage is a closed loop bar linkage in which there is a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, and which includes the first and second linkage members, the first and second linkage members being a matched pair of left and right hand pivot arms constrained to pivot on a common axis of rotation relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and which includes at least one pivotally mounted door assembly defining the bottom discharge governor. The third linkage component includes a drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator.

In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. Displacement of the third linkage component associated with motion of the door assembly between the open position is predominantly in a direction generally parallel to the end slope sheet. In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. During at least an instantaneous portion of motion of the third linkage component while the door assembly is in a position between the open position and the closed position the third linkage component moves parallel to the end slope sheet. In still another feature the third linkage component includes at least a first element and a second element mounted thereto. The first element is pivotally mounted to the first linkage component, and is constrained to move in a lengthwise-vertical plane relative to the first linkage component. The second element has a first connection to the first component the first connection being a pivot connection. The second element has a second connection to the fourth linkage component, the second connection having at least one degree of freedom of motion. The second element is constrained always to be co-planar with the first connection, the second connection, and the main pivot connection. In yet still another feature, the bottom discharge governor includes a door. The actuating cylinder is connected to drive the door operating linkage through a lever assembly. The lever assembly has an over-center lock that is operable to prevent release of the bottom gate to the open position when the actuating cylinder is inactive. In yet a further feature, motion of the first pivot linkage occurs in a longitudinal-vertical plane. The second pivot linkage moves in a plane generally cross-wise to the longitudinal-vertical plane. In still a further feature the main pivot connection is beneath the actuating cylinder when the hopper car is seen in side view. In again another feature one of (a) the main

pivot is beneath the drag link element; and (b) the actuating cylinder is between the main pivot and the drag link element. In a yet still further feature, the hopper includes at least a first end slope sheet, and the bottom discharge governor includes a door. The first end slope sheet is inclined longitudinally downwardly and inboard toward the door. The drag link element is inclined on a slope predominantly parallel to, and adjacent to, the first end slope sheet. The actuating cylinder is oriented along the lengthwise direction, and is also tilted longitudinally downwardly and inwardly toward the door.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper carried by railroad car trucks for motion in a lengthwise direction of the car along railroad tracks. The hopper has a bottom discharge. The bottom discharge has a door movable between a closed position for retaining lading and an open position for permitting egress of lading. A mechanical transmission is connected to the door. The mechanical transmission is oriented lengthwise with respect to the car. A door actuator is connected to the mechanical transmission and is operable to urge the door from the open position toward the closed position, the door actuator being oriented to reciprocate in a first direction. The hopper car has a first lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. The hopper car has a second lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator.

In another feature of that aspect of the invention, the car has a central lengthwise-vertical plane, the door actuator is positioned to reciprocate in the central lengthwise-vertical plane, and the second lock is movable between the engaged and disengaged positions in motion predominantly transverse to the central lengthwise-vertical plane. In another feature, the second lock is mounted on an hinge and pivots in a circumferential direction between the engaged and disengaged positions. In still another feature the second lock is mounted on an hinge, the hinge has an axis lying parallel to the lengthwise vertical plane, and the second lock pivots circumferentially between the engaged and disengaged positions. In another feature, the second lock is biased toward the engaged position. In still another feature, the second lock is biased toward the engaged position. In yet another feature the apparatus is one in which one of: (a) the second lock has a cam and the actuator has a mating cam follower; and (b) the second lock has a cam follower and the actuator has a mating cam. The cam and cam follower are co-operable, and are oriented to deflect the second lock away from the engaged position as the door moves from the open position to the closed position thereof.

In another aspect of the invention, there is a lock mechanism for a door actuating transmission of a railroad gondola car, the door actuating transmission including a reciprocating actuating cylinder mounted to a datum structure, the cylinder being movable forward and backward in an axial direction. The lock mechanism has a body having a first fitting, a second fitting and a third fitting. The first fitting is a mounting by which to connect the lock mechanism to the datum structure. The second fitting is one of (a) a cam for co-operation with a member of the door actuating transmission, that member being a cam follower; and (b) a cam follower for co-operation with a member of the door actuating transmission, that member being a cam. The third fitting includes an abutment for co-operation with a mating fitting of the door actuating transmission. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction.

In another feature, the lock mechanism there has a bias member oriented to urge the third fitting toward the first position thereof. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure. In another feature, the first degree of freedom of motion is an angular degree of freedom, and the predominantly cross-wise motion is predominantly circumferential motion about an axis of rotation. In a feature the first fitting is an hinge, the axis of rotation is an axis of rotation of the hinge, and the axis of rotation of the hinge is substantially parallel to the axial direction of the door actuating transmission. In still another further feature, the first fitting of the lock mechanism includes an hinge and a footing of the hinge for mounting to the datum structure. The axis of rotation is an axis of rotation of the hinge, and the footing has a substantially planar footprint. The axis of rotation of the hinge is angularly inclined relative to the substantially planar footprint. In yet another feature, the lock mechanism has all or any combination of the forgoing additional features.

In still another aspect of the invention there is a railroad hopper car for carrying particulate material. The hopper car there has a hopper and first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction. The hopper is suspended between the first and second end sections. The hopper has a discharge section through which to release lading, and first and second end slope sheets oriented toward the first and second end sections, the slope sheets being inclined in the longitudinal direction to feed the discharge section. The first end section includes a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to either side of the draft sill, and a shear plate mounted to the draft sill and to the main bolster. The shear plate extends lengthwise along the draft sill and cross-wise from side to side of the hopper car. The first end slope sheet of the hopper overhangs the shear plate of the first end section. The hopper car is free of primary structure directly above the shear plate of the first end section under the overhang of the first slope sheet of the hopper.

In another feature of that aspect of the invention, there is one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall. In another feature, the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post

is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. In a further feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet.

In still another feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. In another feature, one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall; the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. The bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. The hopper car has a machinery space bounded by (a) the first slope sheet; (b) the shear plate of the first end section; (c) the end post; and (d) the corner posts, and the machinery space is free of any other primary structure.

In yet another feature the hopper car has at least one longitudinally hinged discharge door, the discharge door being movable cross-wise between open and closed positions. A longitudinally acting pneumatic actuator is at least partially lodged in the machinery space directly above the draft sill. In still yet another feature a brake reservoir is also at least partially lodged in the machinery space. In a yet further feature the shear plate is mounted above and to the main bolster and defines an upper flange thereof. The main bolster has a lower flange downwardly spaced from the upper flange, the lower flange terminating at respective distal end portions at either side of the car. The car includes a side sill running along the car between the first and second end sections. The side sill has an upper flange, the upper flange of the side sill being substantially co-planar and connected to the shear plate. The side sill has a lower flange, the lower flange of the side sill being substantially co-planar with a respective one of the distal end portions of the lower flange of the main bolster. In another further feature, the shear plate defines an upper flange of the draft sill whereby the draft sill upper flange, the shear plate and the side sill upper flange are all substantially co-planar. In another feature the machinery space is free of elephant ears.

In a further aspect of the invention there is a railroad freight car having a freight car body for carrying lading, the body being mounted on railroad car trucks for rolling motion in a longitudinal direction along railroad tracks. The car body includes a draft sill having a draft gear pocket for accommodating draft gear, and a shear plate overlying the draft sill and functioning as an upper flange of the draft sill. The draft sill has an inboard end oriented toward a truck center of one of the trucks, and an outboard end terminating at a striker. The draft sill has an underside and an access opening formed in the underside to admit entry of draft gear into the draft gear pocket from below. The car has a draft gear carrier plate. The carrier plate is mounted to the underside of the draft sill beneath the draft gear pocket. The carrier plate is removable to permit installation of the draft gear into the draft gear pocket. The car body has one of (a) an aperture formed in the shear plate over an inboard end region of the draft sill, the aperture permitting a portion of the draft gear to protrude upwardly therethrough during installation in the draft gear pocket; and (b) a coupler carrier seat defined in the draft sill longitudinally inboard of the striker, and a coupler carrier co-operable therewith, the coupler carrier being removable to permit installation of draft gear in the draft pocket, and, when the coupler carrier is installed, the coupler carrier providing a support for a coupler shank when the coupler shank is connected to the draft gear within the draft sill.

In another feature of that aspect of the invention the freight car has both (a) and (b). In another feature, there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In still another feature, the draft sill has a pair of vertically oriented, longitudinally running spaced apart side webs. The webs have a greater depth of section adjacent to the striker. The webs have respective first and second apertures formed therein. The first and second apertures define the draft gear retainer seat, and the retainer is a sideways slidable shaft that is movable to extend across the draft sill between the first and second apertures in the draft sill side webs. In a further feature there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In another further feature the draft sill has a centerplate centered on the truck center, rear draft stops are welded within the draft sill, and at least a portion of each of the rear draft stops extends longitudinally inboard of the truck center. In still another further feature, the car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of less than 50 inches; and (b) the freight car has a truck center to coupler pulling face length of less than 65 inches when the draft gear is fully extended in draft. In another feature, the railroad freight car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of about 38 inches (+/−2"); and (b) the freight car has a truck center to coupler pulling face length of about 53 inches (+/−2") when the draft gear is fully extended in draft.

These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations.

BRIEF DESCRIPTION OF THE FIGURES

The description is accompanied by a set of illustrative Figures in which:

FIG. **1** is a general arrangement, isometric view of a railroad freight car according to an aspect of the invention with all ancillary systems removed to leave only primary structure visible;

FIG. **2***a* is an isometric view of a sidewall of the gondola car of FIG. **1**;

FIG. **2***b* shows a side view of the sidewall of FIG. **2***a;*

FIG. **2***c* shows an end view of the sidewall of FIG. **2***a;*

FIG. **3***a* shows a perspective view of the end structure of the railroad freight car of FIG. **1**;

FIG. **3***b* is a side view of the structure of FIG. **3***a;*

FIG. **3***c* is a detail of the end structure of FIG. **3***b*, with the near side web of the draft sill removed to show the draft stop, center plate, and coupler relationship.

FIG. **4***a* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully open position;

FIG. **4***b* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in an intermediate position;

FIG. **4***c* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully closed position;

FIG. **5***a* is a side view of the door opening mechanism of FIG. **4***a;*

FIG. **5***b* is a side view of the door opening mechanism of FIG. **4***b;*

FIG. **5***c* is a side view of the door opening mechanism of FIG. **4***c;*

FIG. **6***a* is an end view of the door opening mechanism of FIG. **4***a;*

FIG. **6***b* is an end view of the door opening mechanism of FIG. **4***b*; and

FIG. **6***c* is an end view of the door opening mechanism of FIG. **4***c;*

FIG. **7***a* is a perspective view of a secondary lock mechanism for the door opening mechanism of FIG. **4***a;*

FIG. **7***b* is a plan view of the mechanism of FIG. **7***a;*

FIG. **7***c* is a perspective view of the mechanism of FIG. **7***a* when the door are open

FIG. **7***d* is a view similar to FIG. **7***c*, of the mechanism of FIG. **7***a* in a deflected condition; and

FIG. **7***e* is a perspective view of the mechanism of FIG. **7***a* in a locked position;

DETAILED DESCRIPTION

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings may be taken as being to scale unless noted otherwise.

The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the rail road industry in North America. Following from decision of the CAFC in *Phillips v. AWH Corp*., the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record in accordance with In re Lee, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years experience in the industry in North America or in other former territories of the British Empire and Commonwealth.

In terms of general orientation and directional nomenclature, for rail road cars described herein the longitudinal direction is defined as being coincident with the rolling direction of the rail road car, or rail road car unit, when located on tangent (that is, straight) track. In the case of a rail road car having a center sill, be it a stub sill or a straight-through center sill, the longitudinal direction is parallel to the center sill, and parallel to the top chords. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail, TOR, as a datum. In the context of the car as a whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, or of the centerline of a centerplate at a truck center. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit. Pitching motion is angular motion of a railcar unit about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the rail road car described herein may tend to have both longitudinal and transverse axes of symmetry, a description of one half of the car may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. In this description, the abbreviation kpsi stands for thousand of pounds per square inch. To the extent that this specification or the accompanying illustrations may refer to standards of the Association of American Railroads (AAR), such as to AAR plate sizes, those references are to be understood as at the earliest date of priority to which this application is entitled.

Bottom dumping hopper cars, of which ore cars and coal cars may be examples, may tend to have either longitudinal doors or transverse doors. Longitudinal doors are oriented such that the doors operate on hinges or axes of rotation that are parallel to the direction of travel of the railroad car generally. U.S. Pat. No. 4,250,814 of Stark et al., issued Feb. 17, 1981 and U.S. Pat. No. 3,800,711 of Tuttle, issued Apr. 2, 1974 show cars with longitudinal doors. By contrast, transverse doors are ones in which the axes of rotation of the hinges or other pivots tend to be predominantly cross-wise to the direction of travel, most often perpendicular to it. An example of a transverse door car shown in U.S. Pat. No. 4,843,974 of Ritter et al, issued Jul. 4, 1989.

FIG. **1** shows an isometric view of an example of a rail road freight car **20** that is intended to be representative of a range of rail road cars in which one or more of the various aspects of the present invention may be incorporated. While car **20** may be suitable for a variety of general purpose uses, it may be taken as being symbolic of, and in some ways a generic example of, a flow through car, in which lading is introduced by gravity flow from above, and removed by gravity discharge through gated or valved outlets below. Flow through, or center flow cars may include open topped hopper cars, grain cars, plastic pellet cars, potash cars, ore cars, coal gondolas, and so on. In one embodiment car **20** may be a hopper car such as may be used for the carriage of bulk commodities in the form of a granular particulate, be it in the nature of relatively coarse gravel or fine aggregate in the nature of fine gravel or sand or various ores, ore concentrate or coal. The principle, or primary, structure of car **20** may be symmetrical about both its longitudinal and transverse, or lateral, centerline axes. Consequently, it will be understood that the car has first and second, left and right hand side beams, bolsters and so on.

By way of a general overview, car **20** may have a car body **22** that is carried on trucks **24** for rolling operation along railroad tracks. Car **20** may be a single unit car, or it may be a multi-unit car having two or more car body units, where the multiple car body units may be substantially permanently connected at an articulated connector, or by draw bars, as opposed to by ordinarily releasable AAR couplers. Car body **22**, and the various structural members and fittings described herein may be understood to be typically of metal construction, whether welded or Huck(t.m.) bolted, or riveted together, the metal members being most typically steel, stainless steel, or aluminum, as may be appropriate. Some car builders have also used reinforced plastic composites for car

elements, and those materials could also be employed where suitable. The default construction may be taken as being steel, of which the majority may be mild steel having, typically, a 50 kpsi yield. Car body **22** may have a lading containment vessel or shell **26** such as may include an upstanding wall structure **28** which may have a pair of opposed first and second end walls **30**, **32**, that extend cross-wise, and a pair of first and second side walls **34**, **36** that extend lengthwise, the end walls **30**, **32** and side walls **34**, **36** co-operating to define a generally rectangular form of peripheral wall structure **28**. Wall structure **28** may include top chords **38** running along the top of the walls, and side sills **40** running fore-and-aft along lower portions of the side sheets or side sheet assemblies **42** of side walls **34**, **36**. In some instances, such as that of the illustration of FIG. **1***a*, car **20** may have stub center sills **44** at either end, in which case side walls **34**, **36** may act as deep beams, and may carry vertical loads to main bolsters **90** that extend laterally from the centerplates. In the case of a single, stand alone car unit, draft gear and releasable couplers may be mounted at either end of the stub center sill. In a center flow, or flow through car, the upper portion of the car may typically include means by which to admit lading under a gravity drop system. Such an intake **46**, or entryway may be a large rectangular opening such as that bounded by top chords **38**.

Car body **22** may include end sheets **48** and side sheets **50**. Car **20** of FIG. **1** et seq., is illustrated as a car having a single hopper **52**, a single hopper discharge section **54**, and an outflow or discharge governor in the nature of a discharge door assembly **56**. However, car **20** could, alternatively, be a multiple hopper car. In a multiple hopper car, the car may have laterally extending members or reinforcements, which may be cross-bearers, or cross-bearers with shrouds, or merely shrouds, particularly where the car is a multiple hopper car. These cross-members may run fully across the car from side sill to side sill, and may intersect the center sill, or the center sill shroud as may be. The car may also include upper wall bracing, in the nature of diagonal struts which extend diagonally upwardly and outwardly from the apices of the respective cross-members at the centerline of the car to upper regions of the side walls near or at the top chords; and lateral ties or struts that run across the car from sidewall to side wall to meet the upper ends of the diagonal struts at their wall brackets. Those brackets may be aligned with, and mated through the wall to, the vertical exterior posts that run from the side sill to the top chord and reinforce the walls.

End sheets **48** may be substantially planar slope sheets or slope sheet assemblies that are inclined downwardly in the longitudinally inboard direction to feed the discharge section. Not atypically, each pair of fore- and aft opposed slope sheets may be inclined at equal and opposite angles, and the angles of those sheets may be selected to be somewhat steeper than the free slope angle, or natural talus slope angle of the lading for which the car is designed, such that, when the gates are opened, the lading may tend to flow out, rather than sit at rest.

The primary structure of body **22** of car **20** includes lading containment vessel **26** which is in the nature of hopper **52**. Hopper **52** has an upper portion **58** with substantially vertical wall panels, and a lower stationary portion defined by a set of converging sloped walls, namely the side and end slope sheet assemblies **48** and **50**. At the lower margin of the sloped walls there is the outflow governor, namely door assembly **56**, which, in this instance, may have the form of a pair of first and second, or left and right hand doors **62**, **64**. This containment structure seats on, and is carried by, a pair of first and second end structures, **66**, **68**, at either end of the car. End structures **66**, **68** are in turn carried by trucks **24**. A door operating apparatus or mechanism, or drive train, or transmission, however it may be termed, and identified generally as **70**, is provided to move doors **62**, **64** between open and closed positions.

Considering this structure in greater detail, trucks **24** are most immediately surmounted by center plates **72** of longitudinally extending stub sills **44**. Stub sills **44** in turn carry laterally extending main bolster arms **74** of main bolster **90**. Arms **74** extended perpendicularly away from the centerplate **72**, i.e., they are centered on the truck center, CL-Truck. Side sills **40** run lengthwise along the car between, and tie together, the most laterally outboard extremities of main bolster arms **74**. A shear plate **76** is mounted in an x-y horizontal plane defining the top cover plate of stub sill **44**. Shear plate **76** extends laterally from side sill to side sill, and longitudinally from the fore-and-aft end slope sheet **48** to the laterally extending end sill **78** of the car, which, in this instance may be an upturned flange formed on the longitudinally outboard margin of shear plate **76**. In car **20**, the primary structure includes an end post **80** and a pair of side or corner posts **82**, **84**.

End post **80** is rooted in shear plate **76** in line with center sill **44**, and may have lateral webs or gussets aligned with the webs of stub sill **44** to provide vertical web continuity across shear plate **76**. End post **80** then extends fully between shear plate **76** and top chord **86** of end wall **30** or **32**, as may be. Corner posts **82** and **84** are rooted to, and stand upwardly from, the junction of the laterally outboard ends of left and right hand main bolster arms **74** and side sills **40**. Posts **82** and **84** extend upwardly from this junction to mate with various elements of the end and side walls, as may be described below.

As described in additional detail below, car **20** has an abnormally short distance from the striker **88** to the truck center, i.e., the CL of centerplate **72**. Striker **88** is the vertical planar surrounding face plate at the outboard end of the stub sill **44**. In the terminology of the industry, the portion of the center sill **44** (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center CL-Truck may also be referred to as the draft sill. In car **20**, the short draft sill length, identified as L_{88}, leaves an anomalously small space in which to install other systems, such as the brake reservoir and the door operating pneumatic cylinder. Car **20** has an end of car machinery space, indicated generally as **75**, that is bounded by shear plate **76** on the bottom, the sloped end wall assembly **30** or **32** of the car on the top, main vertical central end post **80**, and main side posts **82**, **84** at the ends of main bolster **90**. This space may be referred to as having the shape, generally, of a triangular prism and is substantially unobstructed by the primary structure of the car. For the purposes of this description, primary structure is defined as the underframe, including side sills and center sill (i.e., including the draft sill), the side walls, the slope sheets and top chords, the hopper construction including the stationary parts of the discharge section, as well as any cross-bearers, cross-ties, bolsters, shear plates and so on. Primary structure excludes secondary or ancillary structure or systems such as ladders, cat-walks and other safety appliances, brakes, brake rods and brake fittings, air hoses, reservoirs and pneumatic fittings, movable door members, door operating linkages, and so on.

In existing cars, this space, **75**, is often occupied or otherwise obstructed by other primary structure, such as so-called "elephant ears". In this context, "elephant ears" are large, substantially triangular planar plates, sometimes provided with central lightening holes, that have one edge fixed along the junction of the center sill webs and the center sill cover plate, and another edge welded to the end slope sheet. The

third edge is typically a free edge. Often these plates lie in a plane that is oriented at an angle to the vertical—i.e., it leans laterally outboard. Car **20** avoids the use of these "elephant ears" and so provides the large unobstructed space shown in FIG. **1***b*.

FIGS. **1** and **2***a*, **2***b* and **2***c*, all show the sidewall of the car, indicated generally as **34** or **36**. Sidewall **34** and **36** function as short beams of low (e.g., less than 4:1, possibly less than 3:1) length-to-depth ratio. Sidewall **34** or **36** can be seen to have a bottom flange or chord member, namely side sill **40**, a top flange or chord member, namely top chord **38**, which may have the form of a square or rectangular hollow structural steel tube; and an intermediate shear force transfer web, namely side sheet assembly **42**. Side sheet assembly **42** may include an upper sheet portion or member **92** that is welded to the outside face of top chord **38** at a lap joint, and that extends downwardly therefrom; and a lower sheet portion or member **94**. Member **94** may have the form of a Z-section, having a first portion, namely an upper flange or leg or margin **96** that extends in a substantially vertical plane and has an uppermost margin that overlaps the lowermost edge or margin of member **92**; a second or intermediate portion **98** that runs in an inclined plane sloping inwardly and downwardly on the slope of the hopper side sheets generally, and a third or bottom portion, namely bottom flange, or leg, or margin **100** that extends in a substantially vertical plane downwardly. Sidewall **34** or **36** also includes a central post, or web stiffener, **102** that has a lowermost first portion **104** an intermediate second portion **106**, and an uppermost third portion **108**.

Side sill **40** includes a channel **110** that is welded toes-inward against the lowermost marginal portion of lower leg **100** to form a closed section. The first or lowermost portion **104** of web stiffener **102** has the form of a quadrilateral gusset having a first edge welded to the upper leg of channel **110**, a second edge welded to the vertical margin **100**, a third edge welded to the sloping portion **98**, and the fourth, laterally outboard, edge being free. As may be noted, portion **104** stands outboard of the sidewall sheet.

Portion **108** is a rectangular web stiffener that is welded to, and extends downwardly from, the underside of top chord **38** along the inside face of vertical web portion **92**. Intermediate portion **106** is a web, or plate, or gusset, that is also a quadrilateral, having a first edge that overlaps, and is welded to, the lower margin of portion **108**. A second edge is welded to the lower region of vertical web portion **92**, and to the upper flange or leg **96**. A third edge is welded along the sloped portion **98** of member **94**. The fourth edge is free, and faces inwardly into the lading containment space of the hopper. Portions **104** and **106** are co-planar, or substantially co-planar, such that stiffener **102** has web continuity through member **94**. The upper margin of the side slope sheet **50** of the hopper discharge section is welded to the lower margin of the inclined or sloped portion **98**, such that the structure presents a continuous sloped surface for containing, and then slidingly discharging, particulate lading. Expressed differently, the web of the sidewall traverses the sidewall stiffener, commencing on its inboard margin at side sill **40**, traverses the web mid-way up the post, and ends along its outboard margin at top chord **38**. In this arrangement, the vertical stiffener, **102**, acts as the web of a T-section, and the local region of the wall section to which it is joined functions as the flange of that T-section.

In this example, the locus of intersection of the side slope sheet plane P_{94} with the plane of the side wall sheet P_{92}, lies above the level of side sill **40** by a substantial distance, indicated as L_{94}. This distance may lie in the range of ¼ to ⅔ of the distance L_{SW} from side sill **40** to top chord **38**, and, in the particular may be about ⅓ of that distance. Further, although the post has stiffening member web continuity in a vertical plane, the wall sheet traverses the stiffening web intermediate the top chord and the side sill, and does so obliquely on the slope of plane P_{94}.

The upper leg of channel **110** forms the upper flange of side sill **40**, and the lower leg of channel **110** forms the lower flange of side sill **40**. Shear plate **76** forms the top flange of main bolster **90**. Main bolster **90** also has a lower or bottom flange **91**. In car **20** the upper leg of channel **110** is co-planar or substantially co-planar with, and is connected in flange continuity with, shear plate **76**. Similarly, the lower leg of channel **110** is co-planar or substantially co-planar with, and connected in flange continuity with, bottom flange **91** of main bolster **90**.

Continuing with the sidewall assembly, the main sheet, namely upper sheet portion **92**, ends at the corners, and there are respective first and second end upper web stiffener portions and inwardly stepped plate members **112**, which may be termed "ears". The top edge of each ear is welded to the inside face of top chord **38** in a lap joint. The longitudinally outboard end edge forms a plane to which the vertical end sheet of the end slope sheet wall abuts and is welded. The bottom edge follows the slope of, and is welded to, end slope sheet **48**. The forward, transversely outwardly bent edge is welded to the upper end portion of side sheet assembly **42**. The lower region of the main sidewall sheet also includes lightening apertures **114**, in the space between the corner posts and the slope of the end slope sheets. Finally, the lower portion of region **100** of the main sidewall sheet has longitudinal extensions **116** that are welded to the side edges of the shear panel, namely shear plate **76**, outboard of main bolster **90**, thereby forming a portion of the peripheral flange of the shear plate.

End walls **30**, **32** each include upper and lower sloped surface members **122** and **124**, which could be made as a single piece, or as two pieces butt-welded together, as here. Upper member **122** has notches **126** formed therein to accommodate corresponding corner posts **82**, **84** as may be, with local reinforcement doublers **128** at the junction. Lower portion **124** tapers in width to match the narrowing width between the sloped side sheets with which it mates. At the upper end of end wall **30** the end wall assembly includes a laterally extending first formed member **130** that has a first, vertical leg **132** that laps the inside face of the top chord **86**, and a bent flange **136** that extends initially horizontally, with a distal lip bent upward to mate perpendicularly with the upper margin **138** of the end slope sheet **48**. The distal tip of end slope sheet **48** is fillet welded to vertical leg **132**. This results in a substantially triangular closed section defining a laterally extending end slope sheet reinforcement beam **140**. The ends of this beam abut, are welded to, and are capped by elephant ears **112**. Vertical leg **132** also lies against, and is welded to, end post **80**.

A formed angle **142** is mounted toes-in at an intermediate height on sloped end wall **48**, forming thereby another hollow section laterally extending end sheet reinforcement or beam **148**. Vertical leg **144** of angle **142** is substantially aligned with the central web of the corner post (be it **82** or **84**) and therefore also with the central web of the main bolster. Another formed angle **150** is welded toes-in to the back of sloped end wall **30** at the level of shear plate, thereby forming yet another slope-sheet reinforcement in the form of a laterally extending beam.

The corner posts **82** and **84** each have a lower corner post flange plate **160** (that includes a lifting lug aperture) that has a bottom tab welded to the outside, or back, of the end of side sill **40** in line with the main bolster, then an angled portion following the angle of the outside edge of the vertically

extending side wall reinforcements, **161**, to an upper end at the juncture of the side slope sheet with the side wall vertical leg of the lower side wall sheet. Each end post has two internal reinforcements **154**. Each corner post also includes an intermediate member, or web, or gusset, or plate **162**, which is considerably wider than intermediate gusset **106**, and a substantially triangular inside edge web stiffener **164**. Plate **162** is a quadrilateral. A first edge of plate **162** runs along the upward and outward slope of wall extension **166**. A second edge runs vertically against the upper leg of wall extension **166**. A third upper edge adjacent runs horizontally along lateral reinforcement beam **148**. The fourth edge runs vertically downward to and along edge stiffener **164**. As such, a vertical post is established.

Considering FIGS. **3***a*, **3***b* and **3***c*, center sill **44** includes a bottom flange or bottom cover plate **165**, and a pair of spaced apart webs **168**. The central region of shear plate **76** forms the top flange, or top cover plate of the center sill. At its inboard end, the center sill terminates centrally under the bottom lateral reinforcement of the end slope sheet **48**. A draft pocket **175** is defined between webs **168**, shear plate **76** and bottom cover plate **165** longitudinally inboard of the striker plate.

Center plate **72** is mounted at truck center CL-Truck, in line with main bolster **90** and the corner posts **82**, **84**. Rear draft stops **172** are welded within the center sill above center plate **72**. As seen in FIG. **3***c*, the inboard end of rear draft stop **172** extends longitudinally inboard of the truck center. While this is known to have been used in at least one single piece, integrally cast draft sill, the inventor is unaware of such a construction in an all-welded fabrication draft sill assembly. The removable draft sill access cover plate, or draft gear carrier plate **174**, which is bolted to the draft sill (i.e., the stub sill) bottom flange margins, is mounted immediately longitudinally outboard of center plate **72**. Front draft stops **176** are, in turn, mounted longitudinally outboard of carrier plate **174**. In this embodiment there is also a removable member, such as a top leeway or access plate **178**, mounted to shear plate **76**. Plate **178** is removed when draft gear **180** is removed or installed. On installation, draft gear **180**, to which yoke **188** is already mounted, is fed into draft pocket **175** from below, on an angle, whereby the rear corner protrudes upwardly through the opening that is otherwise covered by plate **178**. The front end of draft gear **180** is rotated into place, and the rear end is rotated downward. As this occurs, yoke **188** is also raised into place. Plates **178** and **174** are then reinstalled. The shank **182** of the coupler, **184** is inserted, and the coupler key **186** is fed through the slot in front draft stops **176** to link coupler **184**, and yoke **188** in the customary manner. It may be noted that coupler **184** combines an AAR Type E shank with and AAR Type F knuckle with a bottom shelf. Draft gear **180** itself has abnormally short travel, namely about 2½ inches deflection before going solid, as compared to a "normal" deflection of over 3" before going solid.

Draft sill webs **164** have, at their longitudinally outboard end an end portion **190** of increased depth of section with a downwardly protruding bulge or horn, such as might be termed a "chin". End portion **190** has an aperture or slot **192** formed therein to permit lateral sliding insertion of a coupler support, carrier or bar **194** immediately behind striker plate **88**. Removal of bar **194** permits yoke **188** to be swung into place during installation of draft gear **180**. When coupler **184** is installed, the shank may rest on bar **194**. Bar **194** is held in place by bolts that secure it relative to webs **164**. Overall, a coupler installation of very short length is achieved. In this example, L_{88} may be in the range of less than 50 inches, and in one embodiment may be about 38"+/−2", from the truck center to the outboard face of striker plate **88**. An alternative expression of the relative compactness of the draft gear is that the length from the truck center to the pulling face of the coupler, when the draft gear is extended in tension, is in the range of less than 65 inches, and in one embodiment is in the range of 53"+/−2".

Car **20** may also include a door opening mechanism **200**. There are left and right hand, or first and second, doors **62**, **64**. Each door has a proximal, hinged edge **206**, and a distal free edge **208**. The hinges are carried on hinge fittings welded to mounting brackets depending from the slope sheets and side sills. The hinges run parallel to the longitudinal or lengthwise axis of the car, generally such that doors **62**, **64** are longitudinal doors. Each door has the form of a hollow section beam, having a proximal beam **210** along the hinge side, a distal beam **212** along the free edge, internal cross-braces, not shown, and front and back skins or sheets or plates **214**, **216**. The hinges are indicated as **220**, the end closure plates as **222**, **224**. The doors have door seal members **226**, **228** that mutually engage when the doors are moved to a closed position. Seal members **226**, **228** are sprung, such that when they are closed they deflect somewhat and in so doing take on a spring pre-load against each other. The door mechanism includes a pair of first and second, matched left and right hand pivot arms **230**, **232**; a corresponding pair of first and second drag links **234**, **236**; a shared yoke **238**, and a pair of slave links **240**, **242** that each pick up on a knuckle fitting **244**, **246** of each of respective doors **62**, **64**. The whole assembly has left and right hand symmetry.

Inasmuch as, when tripped, doors **62**, **64** open under the influence of gravity, particularly when assisted by the weight of the lading being discharged, one may consider the motion that occurs as the doors are closed in the sequence of views **4***a*, **4***b*, and **4***c*; **5***a*, **5***b*, and **5***c*; and **6***a*, **6***b* and **6***c*. Knuckles **244** and **246** are constrained by geometry to move in circular arcs of fixed radii in planes perpendicular to the respective axes of rotation of doors **62** and **64**, those axes being the hinge axes of their respective hinges **220**, which each lie in a plane parallel to the x-z plane of the car centerline. The plane of rotation of knuckles **244**, **246** will then tend to be perpendicular to the central x-z plane. Slave links **240** and **242** are each of fixed length; each has an end pivotally connected at a two rotational degree of freedom knuckle, be it **244** or **246**, as may be; each of slave links **240** and **242** has another end pivotally connected at a second pivot connection at yoke **238**; and slave links **240** and **242** do not transmit a bending moment, and so therefore pull in pure tension. The upper, or near (i.e., proximal), ends of drag links **234**, **236** are connected to the distal ends of pivot arms **230**, **232** at pivot connections **248**, **250**, which may, if desired, share a common axis of rotation or pivot pin.

Yoke **238** is constrained by symmetry to pull in an x-z plane, which in the embodiment illustrated is the vertical plane of the centerline of the car. As such, movement of yoke **238** away from the plane of motion of knuckles **244** and **246** will necessarily draw knuckle fittings **244** and **246** closer together, and toward the vertical centerline plane of the car, eventually causing resilient door seals **226**, **228** mutually to engage, thus closing the opening. This motion can be achieved by pulling on drag links **234**, **236**. Each pivot connection of slave links **240**, **242** has a single angular degree of freedom. Similarly yoke **238** has an angular degree of freedom about the axis of rotation of the axle, or trunnions, by which it is pivotally mounted to the drag link, or drag links **234**, **236**. This gives the drag link connection two angular degrees of freedom in total. As the drag links are withdrawn, the slave links pull in tension, finding the natural hypotenuse between the plane of the arc of motion of knuckle fittings **244**,

246 and the plane of motion of drag links 234, 236. Since this mechanism operates in tension, pivot connections 248, 250 and knuckle fittings 244, 246 are co-planar, with drag links 234, 236, yoke 238, slave links 240 and 242, and their associated pivot connections also lying in that same plane as well. (See FIGS. 5*a*, 5*b*, 5*c*).

Driving force for this system is provided by an actuator, identified as 260. Actuator 260 may be a pneumatic actuator, which may be charged by the pneumatic system of the train generally, as supplied through the pressurized air connection of the train line. Actuator 260 may include its own reservoir and check valve. Actuator 260 is connected to move a first member, in the nature of a primary driven pivot arm or lever, 262, which is in this instance actually a pair of matched lever arm members, which in turn is pivotally connected to, and drives, a second member in the nature of, a push rod, or, given the symmetrical nature of the assembly, a pair of left and right hand push rods 264 and 266. One or both of push rods 264, 266 may have a secondary member, such as may be an extending arm, or detent, or stop, or abutment, identified as an over-center travel limiter or governor, 268. The far ends of push rods 264, 266 may be connected to either pivot arms 230 (or 232, as may be), or to drag link 234 (or 236, as may be). It may be convenient to connect the far end of push rods 264, 266 at the same pivot connection, or connections 248, 250.

Lever 262 has a first end pivotally mounted to primary structure of car 20 at footings, identified as mounting fixtures, fittings or brackets 270. The drive rod of actuator 260 picks up on lever 262 at an intermediate location, such that lever 262 provides magnification of displacement. Similarly, pivot arms 230, 232 have a first or base end pivotally connected to primary structure at mounting fixtures, fittings, or brackets 272. Actuator 260 is located on the centerline (i.e., in the central x-z plane) of car 20, between and in substance below pivot arms 230, 232. "Below" in this context may be thought of as radially more proximate to the pivot axis P_{270} of brackets 270 than is the pivot axis of connections 248, 250, as well as in the context of being lower than as in closer to Top of Rail. In the past the lever fitting has more commonly been mounted to the slope sheet such that the output pin is lower than the pneumatic cylinder. Turning this arrangement upside down, in effect, and fitting the cylinder may then permit a more compact installation than otherwise. Similarly, the pivot axis, P_{230}, of driven arms 230, 232 is below the output knuckle, i.e., at P_{250}, and is below the actuator cylinder as shown in FIG. 5*b* in which P_{250} lies below the center line CL_{260} or actuator 260. This may be taken in the sense of being further from the plane of the end slope sheets, identified as P_{48}. Expressed differently, actuator 260 lies between the base or datum pivot point P_{250} of driven arms 230, 232 and the plane P_{48} of end slope sheet 48.

As may be noted, the line of action of drag links 234, 236 has a predominant component that is substantially parallel to plane P_{48}. Expressed differently, at some point during midstroke, the line of action will be at least instantaneously parallel to plane P_{48}. Finally, it may be noted that rather than placing actuator 260 on shear plate 76, and orienting actuator 260 such that its longitudinal axis (i.e., the working axis or axis of reciprocation of the actuator), that actuator is itself raised upwardly from the shear plate and oriented to work along a line of action that is tilted downward and longitudinally inboard, the angle of tilt being identified as α_{260}. This angle of inclination lies in the range from horizontal to the angle of inclination of end slope sheet 48, identified in FIG. 5*c* as α_{48}. Placing the mounts and pivot points under the apparatus, raising the actuator cylinder, orienting it on an incline, and making the line of action or the zone swept by the draglinks in the progressions of FIGS. 4*a*, 4*b* and 4*c* (or 5*a*, 5*b* and 5*c*) tend to correspond to a displacement substantially or predominantly parallel to plane P_{48}, all aid in providing a more compact installation, in particular one that is longitudinally short as may suit the short distance from the truck center to the striker. It is also an installation that may tend to leave space for other car systems, such as the brake system.

This arrangement may be thought of in terms of a four bar, or multi-bar, linkage. The first bar of the linkage may be thought of as being the underframe, and structure rigidly mounted to the underframe. This is the datum, or frame of reference member of the linkage. The second member or linkage component is the first pivot arm, 230 (or 232) having a fixed main pivot point, and an output distal pivot point constrained to move on a fixed radius about main pivot point P_{230}. The fourth component or element of the linkage is the second pivot arm, namely 62 or 64, each of which is a second lever or pivot arm mounted to a pivot axis fixed with respect to the first or datum link, and having a distal connection, in this case also a pivot connection, constrained to move in an arc of constant radius about the base pivot axis. The third linkage is the drag link. Although the drag link is made of two portions that are held together at yoke 238, the geometric symmetry of the assembly constrains both the upper portion of the drag link, (i.e., drag link 234, 236) and the lower portions, (i.e., slave links 240, 242) to be co-planar during closing of the doors. In any case, the single input of the actuator cylinder acting through the over-center links against the first pivot arm (at the distal pivot connection) produces a unique output geometry such that position of the elements is determinate as if it were a four bar linkage.

When the door opening apparatus is retracted to the position shown in FIGS. 4*c*, 5*c* and 6*c*, driven primary pivot arms and the over-center links are driven to a slightly over-center relationship such that the pivot connection between the primary pivot arms and the over center arms lies below a line drawn from the primary pivot axis and the over-center link output connection as axis P_{250}. In this condition tensile force on drag links 234 and 236 (as from weight placed on doors 62, 64, for example) will tend to urge the main driven pivot arms, namely lever 262, counter-clockwise as viewed in FIG. 4*c*. Motion in this direction is prevented by the over center stop, 268, thereby defining a first lock that prevents inadvertent opening of doors 62, 64 from moving to the open position when actuator 260 is dormant, i.e., inactive. This first lock is released by reversing actuator 260 to open the doors.

Car 20 has a secondary door mechanism, or secondary latching system, identified generally as 300. This secondary latch system, and, indeed, the door closure linkage apparatus of FIGS. 7*a*-7*e*, are slightly different from those shown in FIGS. 4*a*, 5*a*, and 6*a*. In latching system 300 there is a latch assembly 302, shown in FIGS. 7*a* and 7*b*. Assembly 302 includes a first member, or main member, or plate 304, which performs the function of a body or armature or spider that ties the other various physical elements of the assembly together. Along one edge plate 304 has physical motion constraint fittings, identified as hinge fittings 306, that limit plate 304 (and assembly 302 more generally) to a single degree of freedom, that single degree of freedom limiting plate 304 to motion of any point to motion in a plane perpendicular to the hinge axis, and in particular to pivotal motion in that plane about that axis. To the extent that the hinge axis is substantially or predominantly parallel to the axis of reciprocation of pneumatic actuator 260, that motion can be said to be sideways, or predominantly transverse of cross-wise to that direction of reciprocation.

Plate **304** has a portion or finger, or arm member **308** extending away from the hinge. In this case, arm member **308** extends arcuately away, and has a bent termination, or end, or lip, or tip, indicated at **310**. Another member **312** in the form of a block is mounted, e.g., welded, at the distal end of arm member **308**. Member **312** has the same general shape, a dog-leg bend, as tip **310**. Member **312** has a first, generally inwardly (i.e., away from the tip) facing surface **314** that defines an abutment **316**. Member **312** also has an oblique surface **318** that defines a wear or cam surface, which may be termed a reset cam, or return cam.

Another member **320**, which may have the form of a plate or block, is welded to the major portion of the body of plate **304** relatively close to the hinge axis. The axially foremost face of member **322** is relieved—i.e., it does not define a face in a plane perpendicular to the hinge axis—or to the axis of reciprocation of the pneumatic actuator clevis. This face may be arcuate or chamfered, and so defines a first or deflection cam **324**. That is, as installed, it lies in the path of actuator clevis **330**. When the leading corner of clevis **330** encounters cam **324**, plate **304** will tend to be urged to rotate, i.e., pivot, about its axis in the clockwise direction as viewed looking from actuator **260** toward hopper **52**. Assembly **302** also includes a motion resisting, or return biasing member in the form of a spring, identified as leaf spring **326** that is anchored at the proximal end to stationary structure of the secondary lock footing, or base, **328** which is welded to shear plate **76**. The footprint of base **328** against shear plate **76** is planar. The hinge axis is inclined relative to the plane as shown, the angle of inclination being substantially similar to, and possibly the same as, the mid-stroke angle of inclination of actuator **260** (which, itself, varies slightly during operation). The distal end of spring **326** bears against plate **304** distant from the hinge. Finally, assembly **302** includes reaction force transmission members **332**, **334** in the form of welded flat bars that bear against, i.e., abut, the longitudinally outboard face of mounting fitting **270** when the latch is in the engaged position.

In operation, as actuator **260** works, lost motion is taken up in slot **336** of the distal or forward end **338** of the reciprocating actuator ram. Eventually the end of slot **336** engages a pivot pin **340** of bell crank arm **342** and causes driven member **344** (analogous to driven member **262**), causing it to rotate counterclockwise as viewed in FIG. **7***a*. This forces push rods **346**, **348** (analogous to push rods **264**, **266**) to act against connections **248**, **250**, and hence to force drag links **234**, **236** along their retracting path. Since **262**, **264**, **230** and the car body form a four bar linkage, the output path of connections **248**, **250** is determinate and unique.

While this happens, clevis **338** keeps moving rearward to engage reset cam surface **318**, with the effect that assembly **302** is urged to rotate out of the way, against the resistance of spring **326** (FIG. **7***d*). Eventually the trailing portion of clevis **338** clears cam **324**, and soon thereafter the most longitudinally inboard edge of driven member **344** clears abutment **316**. Assembly **302** then moves under the influence of spring **326** into the locked position shown in FIG. **7***e*. In this locked position, any moment tending to pivot driven member **344** clockwise is reacted not by the hinge fittings, but rather by the reinforcements, namely members **332**, **334**. In this locked position driven member **344** and push rods **346**, **348** are drawn to, and locked in, their over center position.

When the doors are to be released, actuator **260** moves in the opposite direction. The lost motion of the length of slot **336** reverses, such that the end of clevis **338** bears against the release cam, namely cam surface **324**, which causes plate **304** to pivot away, and thus disengages abutment **316**, moving it out of the path of driven member **262** against which it would otherwise abut. The outboard end of slot **336** then engages pin **340**, releasing the over-center hold of driven member **344**, and permitting the doors to open under the influence of gravity.

The cams need not necessarily be on the plate, i.e., the latch body, but could be on the clevis, as shown at **350** in FIG. **4***c*. That is, it is to some extent arbitrary which part is identified as the cam, and which part is identified as the cam follower. The point is that the parts mutually engage such that the one intercepts the other during motion of the actuator cylinder to trip the door opening condition, with the result that the secondary latch is urged to deflect out of the way sideways. In the other direction, of course, the abutment relationship of items **262** and **316** prevents the doors from opening. The apparatus of FIG. **4***c* works in substantially the same way, and combines both arms of the bell crank driven member **344** into a single driven lever, namely lever **262**.

In summary, car **20** has a first lock, the over center lock, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. Car **20** also has a second lock, symbolized by latching system **300**, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator. Actuator **260** is positioned to reciprocate in the central lengthwise-vertical plane of car **20**. Latching system **300** is movable predominantly transverse to the central lengthwise-vertical plane as it pivots in a circumferential direction between the engaged and disengaged positions. The hinge axis lies parallel to the lengthwise vertical plane, and the second lock pivots circumferentially. The second lock is biased toward the engaged position. The lock mechanism can be thought of as having a first fitting, a second fitting and a third fitting. The first fitting is the mounting, **238** by which to connect the lock mechanism to the datum structure. The second fitting is one of a cam or a cam follower for co-operation with a member of the door actuating transmission. The third fitting is the abutment, i.e., **316**, that co-operates with a mating part of the door actuating transmission, in this case the side of lever **262**. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure, namely shear plate **76**. The first degree of freedom of motion is an angular degree of freedom, and is predominantly cross-wise circumferential motion. The axis of rotation is the hinge axis, which is substantially parallel to the axial direction of the door actuating transmission.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

We claim:

1. A railroad hopper car for carrying particulate material, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and first and second end slope sheets oriented toward said first and second end sections, said end slope sheets being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over hanging said shear plate of said first end section; and

said hopper car being free of primary structure directly above said shear plate of said first end section under said overhang of said first end slope sheet of said hopper;

one of:

(a) said first end slope sheet has an upper margin and said hopper car includes an end post extending upwardly from said draft sill to said upper margin of said first end slope sheet; and

(b) said first end slope sheet has an upper margin terminating at an end wall, and said hopper car includes an end post extending upwardly from draft stub sill to said end wall;

said shear plate has a longitudinally outboard margin and said draft sill has a striker located outboard of said longitudinally outboard margin of said shear plate, and said end post is one of:

(a) rooted to said draft sill adjacent to said striker;

(b) rooted to said shear plate adjacent to said longitudinally outboard margin of said shear plate;

said bolster has first and second laterally outboard distal ends, and said hopper car has corner posts extending upwardly from said distal ends of said bolster to said first end slope sheet; and

said hopper car has a machinery space bounded by (a) said first end slope sheet; (b) said shear plate of said first end section; (c) said end post; and (d) said corner posts, and said machinery space is free of any other primary structure.

2. The railroad hopper car of claim **1** wherein said bolster has first and second laterally outboard distal ends, and said hopper car has corner posts extending upwardly from said distal ends of said hopper to said first end slope sheet.

3. The railroad hopper car of claim **1** wherein:

said hopper car has at least one longitudinally hinged discharge door, said discharge door being movable cross-wise between open and closed positions; and

a longitudinally acting pneumatic actuator is at least partially lodged in said machinery space directly above said draft sill.

4. The railroad hopper car of claim **3** wherein a brake reservoir is also at least partially lodged in said machinery space.

5. The railroad hopper car of claim **1** wherein:

said shear plate is mounted above, and to, said main bolster and defines an upper flange thereof;

said main bolster has a lower flange downwardly spaced from said upper flange, said lower flange terminating at respective distal end portions at either side of said car;

said car includes a side sill running along said car between said first and second end sections;

said side sill has an upper flange, said upper flange of said side sill being substantially co-planar with, and connected to, said shear plate; and

said side sill has a lower flange, said lower flange of said side sill being substantially co-planar with a respective one of said distal end portions of said lower flange of said main bolster.

6. The railroad hopper car of claim **5** wherein said shear plate defines an upper flange of said draft sill whereby said draft sill upper flange, said shear plate and said side sill upper flange are all substantially co-planar.

7. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

a first laterally extending reinforcement mounted cross-wise to said first end slope sheet adjacent to said shear plate;

said shear plate of said first end section being connected to said first laterally extending reinforcement;

said first end slope sheet of said first end section being connected to said first laterally extending reinforcement;

said first laterally extending reinforcement defining part of a first hollow section beam extending across said hopper car between said first and second side walls;

said hopper car being free of longitudinally oriented elephant ears extending between said draft sill and said end slope sheet;

said hopper car has a first end wall member running cross-wise between said first and second side walls;

said first end slope sheet has an upper margin that meets said first end wall member at a first junction;

said first end wall member extends upwardly from said first junction;

said first end wall member has a lower portion extending downward of said first junction;

said lower portion of said first end wall member and said upper margin of said first end slope sheet co-operate to define portions of the cross-section of a second hollow section beam extending cross-wise across said hopper car between said first and second side walls.

8. The railroad hopper car of claim **7** wherein said laterally extending reinforcement member includes a first edge mounted cross-wise along said first end slope sheet; a second edge mounted cross-wise along said first end slope sheet and spaced from said first edge, and a third portion mounted across said shear plate of said first end section.

9. The railroad hopper car of claim **7** wherein said laterally extending member has a pair of first and second spaced apart toes, and said laterally extending member is mounted toes-in against said first end slope sheet, whereby said first hollow section beam is defined by said laterally extending reinforcement and said first end slope sheet.

10. The railroad hopper car of claim **7** wherein said laterally extending reinforcement has, when seen in section, a first toe, a second toe, and a back; said laterally extending reinforcement is mounted toes-in against said first end slope sheet; and said back is mounted to said shear plate of said first end section.

11. The railroad hopper car of claim **10** wherein said laterally extending reinforcement is an angle iron mounted toes-in to said first end slope sheet.

12. The railroad hopper car of claim **7** wherein said lower portion of said first end wall member has a lower margin that is bent to meet said upper margin of said first end slope sheet at a location lower than said first junction.

13. The railroad hopper car of claim **7** wherein said first end wall member has an upper margin that terminates at a top chord, said top chord extending from side to side of said hopper car.

14. The railroad hopper car of claim **7** wherein said car includes an upstanding end post, said end post being mounted over said draft sill longitudinally outboard of said main bolster and extending upwardly therefrom to meet said first end wall member.

15. The railroad hopper car of claim **7** wherein an intermediate beam extends across said first end slope sheet between said first and second side walls at a position intermediate said first hollow section beam and said second hollow section beam.

16. The railroad hopper car of claim **15** wherein said intermediate beam includes a cross-wise extending structural member mounted toes-in against said first end slope sheet to define a closed hollow section.

17. The railroad hopper car of claim **7** wherein said first and second side walls of said hopper car define sidewalls of said hopper, and said first and second side walls include end portions that are stepped laterally inboard, and said second hollow section beam extends between said end portions of said first and second side walls that are stepped laterally inboard.

18. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

a first laterally extending reinforcement mounted cross-wise to said first end slope sheet adjacent to said shear plate;

said shear plate of said first end section being connected to said first laterally extending reinforcement;

said first end slope sheet of said first end section being connected to said first laterally extending reinforcement;

said first laterally extending reinforcement defining part of a first hollow section beam extending across said hopper car between said first and second side walls;

said hopper car being free of longitudinally oriented shear webs ears extending between said draft sill and said end slope sheet;

said hopper car has second, and third hollow section beams as well as said first hollow section beam, said first, second and third hollow section beams extending thereacross between said first and second side walls thereof;

said first end slope sheet has an uppermost margin, and said second hollow section beam runs along said uppermost margin of said first end slope sheet;

said third hollow section beam is located intermediate said first and second hollow section beams;

said hopper car has an end post mounted over said draft sill, said end post being located longitudinally outboard of said main bolster of said first end section;

said end post extends upwardly to meet said second hollow section beam;

said hopper car has first and second side sills running longitudinally along either side thereof, said first and second side walls extending upwardly of said first and second side sills respectively;

said first and second side sills mate with first and second ends of said main bolster of said first end section; and

said first and second side sills have upper flanges that mate with said shear plate of said first and section.

19. The railroad hopper car of claim **18** wherein:

there is an end wall that extends from sidewall to sidewall;

said end wall has an upper portion that has an upper margin terminating at a top chord of said end wall;

said first end slope sheet has an uppermost margin, said uppermost margin of said first end slope sheet meeting said end wall along a first juncture;

said end wall has a lower portion extending below said first juncture, said lower portion being bent to define a portion of said second hollow section beam; and

said end post extends past said second hollow section beam along said end wall to mate with said top chord of said end wall.

20. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end

slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

a first laterally extending reinforcement mounted cross-wise to said first end slope sheet adjacent to said shear plate;

said shear plate of said first end section being connected to said first laterally extending reinforcement;

said first end slope sheet of said first end section being connected to said first laterally extending reinforcement;

said first laterally extending reinforcement defining part of a first hollow section beam extending across said hopper car between said first and second side walls;

said hopper car being free of longitudinally oriented elephant ears extending between said draft sill and said end slope sheet;

said main bolster of said first end section of said railroad hopper car has first and second ends at laterally outboard extremities thereof;

said hopper car has first and second corner posts mounted at said first and second ends of said main bolster of said first end section, said corner posts extending upwardly from said main bolster to said first end slope sheet;

said draft sill has a longitudinally outboard end;

an end post stands upwardly of said longitudinally outboard end of said draft sill;

a machinery space is defined above said shear plate, below said first end slope sheet, longitudinally inboard of said end post, and between said corner posts; and

said machinery space is free of any other primary structure.

21. The railroad hopper car of claim **20** wherein:

said hopper has a movable door by which egress of lading is governed;

said hopper car has an actuator and a drive train, said drive train being connected between said actuator and said door, said actuator being operable to move said door; and

said actuator is mounted in said machinery space.

22. The railroad hopper car of claim **21** wherein said first side wall has an aperture formed therein at a location higher than said shear plate, lower than said first end slope sheet, and longitudinally inboard of said first corner post.

23. The railroad hopper car of claim **20** wherein

said first and second side walls of said car have openings defined therein longitudinally inboard of said respective corner posts, above said shear plate, and below said first end slope sheet.

24. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate overlying said draft sill and said main bolster, said shear plate extending along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

there being a first end wall extending between said first and second side walls;

said first end slope sheet having an uppermost margin, said uppermost margin meeting said first end wall at a first junction;

said hopper car having a first beam extending cross-wise between said first and second side walls at said first junction of said uppermost margin of said first end slope sheet and said first end wall, said first beam being a beam of hollow section;

said first end wall has an upper portion and a lower portion;

said upper portion of said first end wall extends upwardly of said first junction of said uppermost margin of said first end slope sheet and said first end wall;

said lower portion of said end wall extends downwardly of said first junction of said uppermost margin of said first end slope sheet and said first end wall; and

said lower portion of said first end wall forms part of said first beam;

said draft sill having longitudinally extending draft sill webs;

said first end section being free of longitudinally oriented elephant ears extending upwardly of said draft sill webs to meet said end slope sheet;

said lower portion of said first end wall has a margin, and said margin is bent to mate with said first end slope sheet as a second junction distant from the first junction, said lower portion of said first end wall and said uppermost margin of said first end slope sheet co-operating to define said first beam.

25. The railroad hopper car of claim **24** wherein an end post is mounted over said draft sill outboard of said main bolster, said end post extending upwardly to meet said first beam.

26. The railroad hopper car of claim **25** wherein:

said upper portion of said first end wall extends upwardly of said first junction to end at a top chord; said top chord extends across said hopper car between said first and second side walls; and

said end post extends past said first beam to terminate at said top chord.

27. The railroad hopper car of claim **25** wherein:

said main bolster has first and second ends; and

respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom.

28. The railroad hopper car of claim **27** wherein: a machinery space is defined above said shear plate, in the lee of said first end slope sheet, longitudinally inboard of said end post and between said first and second corner posts; and said machinery space is free of any other primary structure.

29. The railroad hopper car of claim **28** wherein:
said first side wall has an aperture formed therein in a location that is longitudinally inboard of said first corner post, above said shear plate, and leeward of said first end slope sheet;
said hopper has a movable gate operable to govern egress of lading from said hopper;
there is an actuator mounted in said machinery space, and a drive train connecting said actuator to said gate.

30. The railroad hopper car of claim **24** wherein a second beam is mounted across said first end slope sheet adjacent said shear plate.

31. The railroad hopper car of claim **30** wherein a third beam is mounted across said first end slope sheet intermediate said first and second beams, and said third beam is formed of a structural member mounted toes-in against said first end slope sheet to define an hollow section.

32. A railroad hopper car, said hopper car comprising:
a hopper;
first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;
said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;
said first end section including a draft sill extending in the longitudinal direction, said draft sill having first and second spaced apart longitudinally running draft sill webs and a draft pocket defined therebetween;
said first end section including a main bolster extending cross-wise to said draft sill;
said first end section having a truck center where said main bolster meets said draft sill;
said draft sill having a striker end longitudinally outboard of said truck center;
said first end section including a shear plate;
said shear plate overlying said draft sill webs and said main bolster, said shear plate extending longitudinally along said draft sill and cross-wise from side to side of said hopper car;
said shear plate having an outboard margin running across said car distant from said truck center and proximate said striker end;
said first end slope sheet over-hanging said shear plate of said first end section;
first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;
there being a first end wall extending between said first and second side walls;
said first end slope sheet having an uppermost margin, said uppermost margin meeting said first end wall at a first junction;
said hopper car having a first beam extending cross-wise between said first and second side walls at said first junction of said uppermost margin of said first end slope sheet and said first end wall, said first beam being a beam of hollow section;
said first end wall is surmounted by a cross-wise running top chord;
said first end wall includes a panel extending downwardly from said cross-wise running top chord;
said first end section includes an end post extending upwardly of said draft sill, said end post being mounted above said draft sill distant from said truck center and proximate said striker end;
said end post extending upwardly to meet said first beam and said top chord;
said first end section being free of longitudinally oriented elephant ears extending upwardly of said draft sill webs of said draft sill to meet said first end slope sheet; and
said hopper car having a second beam extending cross-wise between said first and second side walls, said second beam being a beam of hollow section; and
said second beam being connected to said shear plate.

33. The railroad hopper car of claim **32** wherein a third beam is mounted across said first end slope sheet intermediate said first and second beams.

34. The railroad hopper car of claim **33** wherein said third beam is formed of a structural member mounted toes-in against said first end slope sheet to define an hollow section.

35. The railroad hopper car of claim **32** wherein:
said main bolster has first and second ends; and
respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom to meet said first end slope sheet.

36. The railroad hopper car of claim **35** wherein:
a machinery space is defined above said shear plate and under said first end slope sheet; and
a door actuator is mounted above said shear plate and under said first end slope sheet.

37. The railroad hopper car of claim **35** wherein:
a machinery space is defined above said shear plate and under said first end slope sheet;
said first side wall has an aperture formed therein in a location that is longitudinally inboard of said first corner post, above said shear plate, and leeward of said first end slope sheet;
said hopper has a movable gate operable to govern egress of lading from said hopper;
there is an actuator mounted in said machinery space, and a drive train connecting said actuator to said gate.

38. The railroad hopper car of claim **32** wherein:
said main bolster has first and second ends; and
respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom;
said first side wall has an opening formed therein, said opening being located longitudinally inboard of said first corner post, upward of said shear plate, leeward of said first end slope sheet.

39. The railroad hopper car of claim **32** wherein said draft sill has a longitudinally outboard end, and a striker plate mounted at said longitudinally outboard end; and said draft sill has a length between said truck center and said striker plate that is less than 50 inches.

40. The railroad hopper car of claim **32** wherein
said railroad hopper car has first and second end section, and said hopper is carried thereby;
said first and second side walls each have a respective side sill and a top chord;
said first side wall extends from said side sill to said top chord;
said first side wall has a predominantly upwardly running side wall stiffener mounted thereto, said side wall stiffener being located at a longitudinal station intermediate the trucks;
said first side wall having a first region, said first region being a lower region thereof;

said first side wall having a second region, said second region being an upper region thereof;

said side wall stiffener having a first portion, said first portion being a lower portion thereof;

said first portion being mounted to said first region of said first side wall;

said side wall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said side wall;

said first portion of said first side wall stiffener being laterally outboard of said first region of said first side wall;

said second portion of said side wall stiffener being laterally inboard of said second region of said first side wall;

said side wall having a continuous section between said first and second regions thereof; and

said side wall stiffener having web continuity between said first and second portions thereof.

41. The railroad hopper car of claim **40** wherein said first and second portions of said side wall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

42. The railroad hopper car of claim **41** wherein said first side wall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said side wall stiffener from an inboard margin thereof to an outboard margin thereof, and said stiffener having vertical web continuity through said transition portion.

43. The railroad hopper car of claim **40** wherein:

said first side wall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said side wall stiffener from an inboard margin thereof to an outboard margin thereof;

said hopper includes first and second sloped side sheets; and

said first sloped side sheet meets said first side wall at said transition portion.

44. The railroad hopper car of claim **43** wherein said first side wall has an overall height from said side sill to said top chord, L, and said transition portion is located a distance above said side sill that is in the range of ¼ to ⅔ L.

* * * * *

EXHIBIT A2

EXHIBIT A2

Documents and Things to be Produced by Canadian National Railway Company

DEFINITIONS

1. "Canadian National," "CN," "You" and "Your" means Canadian National Railway Company, its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. Canadian National Railway Company is a Québec company having a principal place of business at 935 de La Gauchetière Street West Montreal, Québec, Canada H3B 2M9.

2. "DMIR" means the Duluth, Missabe, and Iron Range Railway.

3. "Plaintiff" or "NSC" refers to National Steel Car Limited, the Plaintiff in the Action, its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. National Steel Car Limited is an Ontario corporation having a principal place of business at 600 Kenilworth Ave N, P.O. Box 2450, Hamilton, ON L8N 3J4, Canada.

4. "Defendants" or "FreightCar" refers to FreightCar America, Inc., a Defendant in the Action, its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. FreightCar America, Inc. is a Delaware Corporation having an address at 125 South Wacker Drive, Chicago, IL 60606.

5. "Greenbrier" refers to The Greenbrier Companies, Inc., its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. The Greenbrier Companies Inc. is an Oregon corporation having an address at One Centerpointe Drive, Suite 200 Lake Oswego, Oregon 97035.

6. "ARI" refers to American Railcar Industries, Inc., its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. American Railcar Industries, Inc. was a North Dakota corporation having an address at 100 Clark Street, St. Charles, Missouri 63301.

Successor companies include Greenbrier, ITE Management L.P., and American Industrial Transport (AITX).

7. "TrinityRail" refers to Trinity Industries, Inc., its subsidiaries, divisions, predecessor and successor companies, affiliates, parents, any partnership or joint venture to which it may be a party, and each of its and/or their employees, agents, officers, directors, representatives, consultants, accountants, and attorneys, including any person who served in any of these capacities during any relevant time period. Trinity Industries, Inc. is a Delaware Corporation having an address at 14221 N. Dallas Parkway, Suite 1100, Dallas, TX 75254.

8. "Rail Car Competitors" include at least Greenbrier, ARI, and TrinityRail, or any other manufacturer of rail cars that supplied Jennies to You or submitted bids or considered submitting bids for Jennies to You.

9. "Jennies" refer to open-top bottom-discharge hopper rail cars for use on the DMIR.

10. "Action" refers to *National Steel Car Limited v. FreightCar America, Inc., et al*, No. 24-594-JLH-CJB (D. Del.).

11. The "'892 Patent" refers to U.S. Patent No. 8,166,892 entitled "Railroad Gondola Car Structure and Mechanism Therefor," issued on May 1, 2012, a copy of which is attached hereto as Exhibit A2-1.

12. The "'515 Patent" refers to U.S. Patent No. 8,132,515 entitled "Railroad Gondola Car Structure and Mechanism Therefor," issued on March 13, 2012, a copy of which is attached hereto as Exhibit A2-2.

13. The "Asserted Patents" refers to the '892 Patent and the '515 Patent.

14. "Related Patents" include any patent or application, whether in the U.S. or Canada, that is a parent, continuation, or divisional of, or otherwise related to, any Asserted Patent.

15. The term "document" is used in its broadest sense to include any documents or electronically stored information stored in any medium from which information can be obtained now or at any time in Your possession, custody, or control. A person or entity is deemed in control of a document if the person or entity has any ownership, possession, or custody of the document, or the right to secure the document or a copy thereof from any person or public or private entity having physical possession thereof. If a draft document has been prepared in several copies that are not identical, or if the original identical copies are no longer identical due to subsequent notation, each non-identical document is a separate document.

16. "Relate" or "Relating to" means consisting of, referring to, reflecting, concerning, or being in any way logically or factually connected with the matter discussed.

17. "Communication" means the transmission of information or data in any form, including, without limitation, written, oral, visual or electronic transmissions.

18. "Including" means including, but not limited to.

19. The terms "and" and "or" should be construed either conjunctively or disjunctively as necessary to bring within the scope of the request all responses that might otherwise fall outside the scope of this request.

20. The terms "all," "any," or "each" encompass any and all of the matter discussed.

21. The use of singular form includes plural and vice versa.

22. The use of present tense includes past tense and vice versa.

INSTRUCTIONS

1. Any objections to the production of documents requested herein shall be made in writing and delivered to the office of Ice Miller LLP, 1500 Broadway, Suite 2900, New York, NY 10036.

2. All documents are to be produced as they are ordinarily kept with any identifying labels, file markings, or similar identifying features, or shall be organized and labeled to correspond to the categories requested herein. If there are no documents in response to a particular request or if You withhold any responsive documents or categories of documents based on any objections, You shall state so in writing.

3. These requests shall apply to all documents in Your possession, custody, or control. If You know of the existence, past or present, of any documents requested herein, but are unable to produce such documents because they are not presently in Your possession, custody, or control or no longer in existence, include a statement:

(a) identifying the document;

(b) describing where the document is now, if known;

(c) identifying who has control of the document, if known;

(d) describing how the document became lost or destroyed or was transferred, if known; and

(e) identifying each of those persons responsible for or having knowledge of the loss, destruction, or transfer of the document from Your possession, custody, or control.

4. Each request contemplates production of all documents in their entirety. If only a portion of a document is responsive to one or more requests, the document shall be produced in its entirety.

5. Each responsive document shall be produced along with all drafts without abbreviation or redaction.

6. If any document is withheld in whole or in part for any reason including, without limitation, a claim of privilege, work product, or other business confidentiality or trade secret protection, set out separately for each document:

(a) the ground of privilege or protection claimed;

(b) each and every basis under which the document is withheld;

(c) the type of document;

(d) its general subject matter;

(e) the document's date; and

(f) other information sufficient to enable a full assessment of the applicability of the privilege or protection claims, as required by FRCP 26(b)(5), the court's local rules, and the judge's individual practice rules.

7. To the extent You assert that a document contains information that should be protected from disclosure (based on the attorney-client privilege, work product doctrine, or another protection) and non-privileged information, the non-privileged portions of the document must be produced. For each document, indicate the portion of the document withheld by stamping the words "MATERIAL REDACTED AS [BASIS FOR PROTECTION]" on the document in an appropriate location that does not obscure the remaining text.

8. If there are no documents in response to any particular request, You shall state so in writing.

REQUESTS FOR PRODUCTION

1. Documents sufficient to show any requirements or desired features for Jennies communicated to NSC, FreightCar and/or, Rail Car Competitors during any bidding or sourcing process between 2007 and 2024.

2. Documents sufficient to show any specifications or drawings for Jennies proposed, constructed, sold, or offered by NSC, FreightCar, and/or Rail Car Competitors.

3. Documents sufficient to show any proposals, bids, or offers for the provision of Jennies to Canadian National by NSC, FreightCar, and/or Rail Car Competitors.

4. Communications by or to any of CN, NSC, FreightCar, and/or Rail Car Competitors regarding Jennies, including any specifications or drawings thereof.

5. Communications between NSC and CN regarding any NSC invention practiced by NSC Jennies.

6. Communications between NSC and CN regarding any NSC patents, including the Asserted Patents and any Related Patent.

7. Communications between CN and its subsidiaries regarding any Asserted Patent, Related Patent, or NSC invention practiced by NSC Jennies.

8. Communications by or to any of CN, FreightCar, and/or Rail Car Competitors regarding any Asserted Patent, Related Patent, or NSC invention practiced by NSC Jennies.

9. All Documents delivered by NSC, FreightCar, and/or ARI in connection with any contract to supply Jennies.

10. Documents and Communications relating to inspections of Jennies by NSC, FreightCar, and/or any Rail Car Competitors between 2018 and 2024.

11. Documents and Communications relating to technical details or specifications of NSC Jennies provided by You to FreightCar and/or any Rail Car Competitors, or vice-versa, between 2007 and 2024.

12. Documents and Communications relating to Your rationale for the decision to purchase NSC Jennies in or around 2009, including the features or advantages of the NSC Jennies and/or bid that led to that decision vis-à-vis other Jennies and/or bids considered at that time.

13. Documents and Communications relating to Your rationale for the decision to purchase ARI Jennies after purchasing NSC Jennies, including the features or advantages of the ARI Jennies and/or bid that led to that decision vis-à-vis other Jennies and/or bids considered at that time.

14. Documents and Communications relating to Your rationale for the decision to purchase FreightCar Jennies in or around 2023, including the features or advantages of the FreightCar Jennies and/or bid that led to that decision vis-à-vis other Jennies and/or bids considered at that time.

15. Maintenance records for Jennies proposed, constructed, sold, or offered by NSC, ARI, and/or FreightCar.

16. Documents sufficient to show who imported any FreightCar Jennies into the United States.

17. All contracts for Jennies between 2007 and 2024 and any documents related thereto.

18. All intellectual property licenses related to Jennies or open-top, bottom-discharge railcars.

19. All analyses or opinions regarding any Asserted Patent or Related Patent.

20. Records of any meetings with You, CN, NSC, FreightCar, and/or any Rail Car Competitors regarding Jennies or the sale or offer for sale thereof.

EXHIBIT A2-1

US008166892B2

(12) **United States Patent**
Forbes et al.

(10) **Patent No.: US 8,166,892 B2**
(45) **Date of Patent: May 1, 2012**

(54) **RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR**

(75) Inventors: **James W. Forbes**, Campbellville (CA); **Marcus Thiesen**, Hamilton (CA); **Dave Keats**, Brantford (CA)

(73) Assignee: **National Steel Car Limited** (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 284 days.

(21) Appl. No.: **12/559,065**

(22) Filed: **Sep. 14, 2009**

(65) **Prior Publication Data**

US 2011/0041724 A1 Feb. 24, 2011

(30) **Foreign Application Priority Data**

Sep. 11, 2009 (CA) 2678447
Sep. 14, 2009 (CA) 2678605

(51) **Int. Cl.**
B61D 17/00 (2006.01)

(52) **U.S. Cl.** **105/406.1**; 105/396; 105/404

(58) **Field of Classification Search** ..... 105/199.4, 105/406.1, 413, 414, 415, 420, 247, 244, 105/250, 254, 396, 404; 213/50, 51, 56, 213/60, 61, 75 R

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

673,103 A * 4/1901 Williamson 105/248

(Continued)

FOREIGN PATENT DOCUMENTS

CA 1082524 A1 7/2009

(Continued)

OTHER PUBLICATIONS

Freight Cars: Hopper, Ore; Car Builders' Cyclopedia, 1937, pp. 313-320, 14th ed., Simmons-Boardman Publishing Corporation, New York, NY.

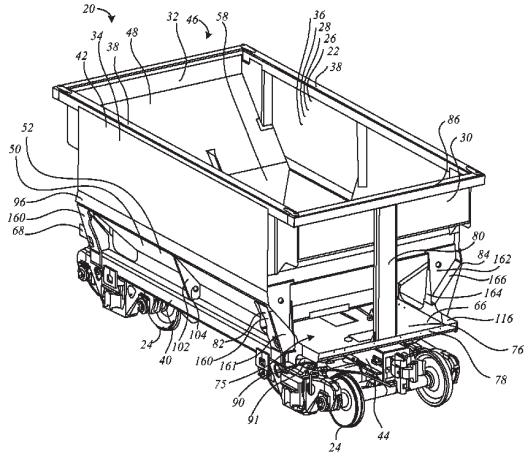
(Continued)

Primary Examiner — S. Joseph Morano
Assistant Examiner — Jason C Smith
(74) *Attorney, Agent, or Firm* — Hahn Loeser & Parks, LLP; Michael H. Minns

(57) **ABSTRACT**

A railroad gondola car has a hopper carried between two trucks. The hopper has convergent end and side slope sheets that feed a bottom discharge. The bottom discharge has a pair of longitudinal doors. The door closing mechanism is a mechanical transmission that includes a set of linkages running from the door to a reciprocating pneumatic cylinder. The linkages run generally parallel to the slope sheet. The car has a very short draft installation that includes a removable coupler carrier bar, and the main shear plate has a removable draft gear installation panel. There is a machinery space above the end section shear plate. It is overhung by the slope sheet that is substantially unobstructed by any other primary structure. The pneumatic cylinder is mounted on an angle in this unobstructed machinery space, oriented longitudinally over the draft sill beneath the main drag link of the mechanical transmission, and above the main pivot of the driving input lever of the transmission. The main lever is bifurcated, and straddles the pneumatic cylinder. The mechanism includes a primary lock in the form of an over center lever arrangement, and a compact secondary lock that acts sideways rather than lengthwise. The sidewalls of the car include vertical stiffeners and side sheets. The lower portion of the side sheets lies laterally inboard of the stiffener web, while the upper portion lies laterally outboard of the stiffener web. The side slope sheet of the hopper meets the sidewall at the transition of the sidewall sheet from the inside-the-post to the outside-the-post condition.

15 Claims, 18 Drawing Sheets



U.S. PATENT DOCUMENTS

763,186	A		6/1904	Johnson	
1,421,439	A		7/1922	Finckh	
3,173,381	A		3/1965	Charles et al.	
3,187,684	A		6/1965	Ortner	
3,405,655	A	*	10/1968	Dorey	105/250
3,408,956	A		11/1968	Rebenok et al.	
3,483,830	A		12/1969	McGrath	
3,577,932	A		5/1971	Pulcrano et al.	
3,596,609	A		8/1971	Ortner	
3,611,947	A		10/1971	Nagy	
3,654,873	A		4/1972	Floehr	
3,710,730	A	*	1/1973	Austgen et al.	105/250
3,717,109	A		2/1973	Miller	
3,717,110	A		2/1973	Miller	
3,800,711	A		4/1974	Tuttle	
3,807,316	A		4/1974	Miller	
3,815,514	A		6/1974	Heap	
3,818,842	A		6/1974	Heap	
3,863,986	A		2/1975	Mentessi	
3,872,796	A		3/1975	Adler et al.	
3,878,794	A		4/1975	Adler	
3,931,768	A		1/1976	Price et al.	
3,949,681	A		4/1976	Miller	
3,994,238	A		11/1976	Adler	
4,106,813	A		8/1978	Goodbary	
4,120,409	A		10/1978	vander Werff	
4,194,450	A		3/1980	Miller	
4,222,334	A		9/1980	Peterson	
4,224,877	A	*	9/1980	Stark et al.	105/250
4,232,989	A	*	11/1980	Miller	414/387
4,246,849	A	*	1/1981	Gramse	105/251
4,250,814	A		2/1981	Stark et al.	
4,252,068	A		2/1981	Nolan	
4,348,962	A	*	9/1982	Smith	105/248
4,361,097	A	*	11/1982	Jones et al.	105/406.1
4,484,527	A	*	11/1984	O'Hara	105/247
4,542,701	A		9/1985	Fischer et al.	
4,555,033	A		11/1985	Miller	
RE32,189	E	*	6/1986	Adler et al.	105/377.07
4,601,244	A		7/1986	Fischer	
4,637,320	A	*	1/1987	Paton et al.	105/406.1
4,740,130	A		4/1988	Prins	
4,800,820	A	*	1/1989	Tomaka	105/406.1
4,843,974	A		7/1989	Ritter et al.	
4,884,511	A		12/1989	Hallam et al.	
4,893,568	A	*	1/1990	Adams	105/416
4,898,101	A	*	2/1990	Harter	105/247
5,063,858	A		11/1991	Dugge	
5,086,709	A		2/1992	Fischer et al.	
5,144,895	A		9/1992	Murray	
5,163,372	A		11/1992	Galvan et al.	
5,181,474	A	*	1/1993	Miller	105/355
5,249,531	A		10/1993	Taylor	
5,261,333	A		11/1993	Miller	
5,813,353	A	*	9/1998	Sauter	105/406.1
5,823,118	A		10/1998	Manstrom	
6,604,469	B1		8/2003	Galvan et al.	
6,745,701	B2		6/2004	Elder	
6,877,440	B1	*	4/2005	Kilian et al.	105/406.1
7,080,598	B2	*	7/2006	Creighton et al.	105/247
7,367,272	B2		5/2008	Taylor	
7,681,507	B2	*	3/2010	Herzog et al.	105/286
7,735,426	B2	*	6/2010	Creighton et al.	105/286
7,780,021	B2		8/2010	Forbes	
7,784,411	B2	*	8/2010	Forbes	105/406.1
2007/0277696	A1	*	12/2007	Forbes	105/406.1
2010/0011987	A1	*	1/2010	Forbes	105/406.1
2010/0219148	A1	*	9/2010	Forbes et al.	213/51
2010/0251922	A1	*	10/2010	Forbes et al.	105/240
2011/0041724	A1	*	2/2011	Forbes et al.	105/240

FOREIGN PATENT DOCUMENTS

CN	101486347		7/2009
EP	0543279	B1	5/1995
EP	1790547	A1	5/2007
EP	1798103	A1	6/2007
GB	1318571		5/1973
GB	2013598		8/1979

OTHER PUBLICATIONS

A.C.F. Covered and Open Top Hopper Cars; Car Builders' Cyclopedia, 1943, pp. 281-289, 16th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1957, pp. 265-272, 20th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1961, pp. 246-258, 21st ed., Simmons-Boardman Publishing Corporation, New York, NY.

Car and Locomotive Cyclopedia, 1966, 10 pages, 1st ed., Simmons-Boardman Publishing Corporation, New York, NY.

5 Photographs of Quebec Iron and Titanium (QIT) ore hopper car No. 556, dated Aug. 15, 2007.

Drawing of QIT car dated Aug. 27, 2007.

2 Sheets of Details of End Structure of an Admitted Prior Art Grain Car of National Steel Car showing End Post, Lateral Intermediate Stub Wall, Elephant Ears Arrangement and End Slope Sheet to Shear Plate Connection at least as early as Jan. 1, 2001.

Reproduction of Design Drawing of Dulth, Missabi & Iron Range (DM&IR) Open Topped Ore Hopper Car General Arrangement Drawing 8760 Drawn Apr. 8, 1950, (Quality Poor in Original), Showing Rear Draft Stops Extending Inboard of Truck Center.

* cited by examiner

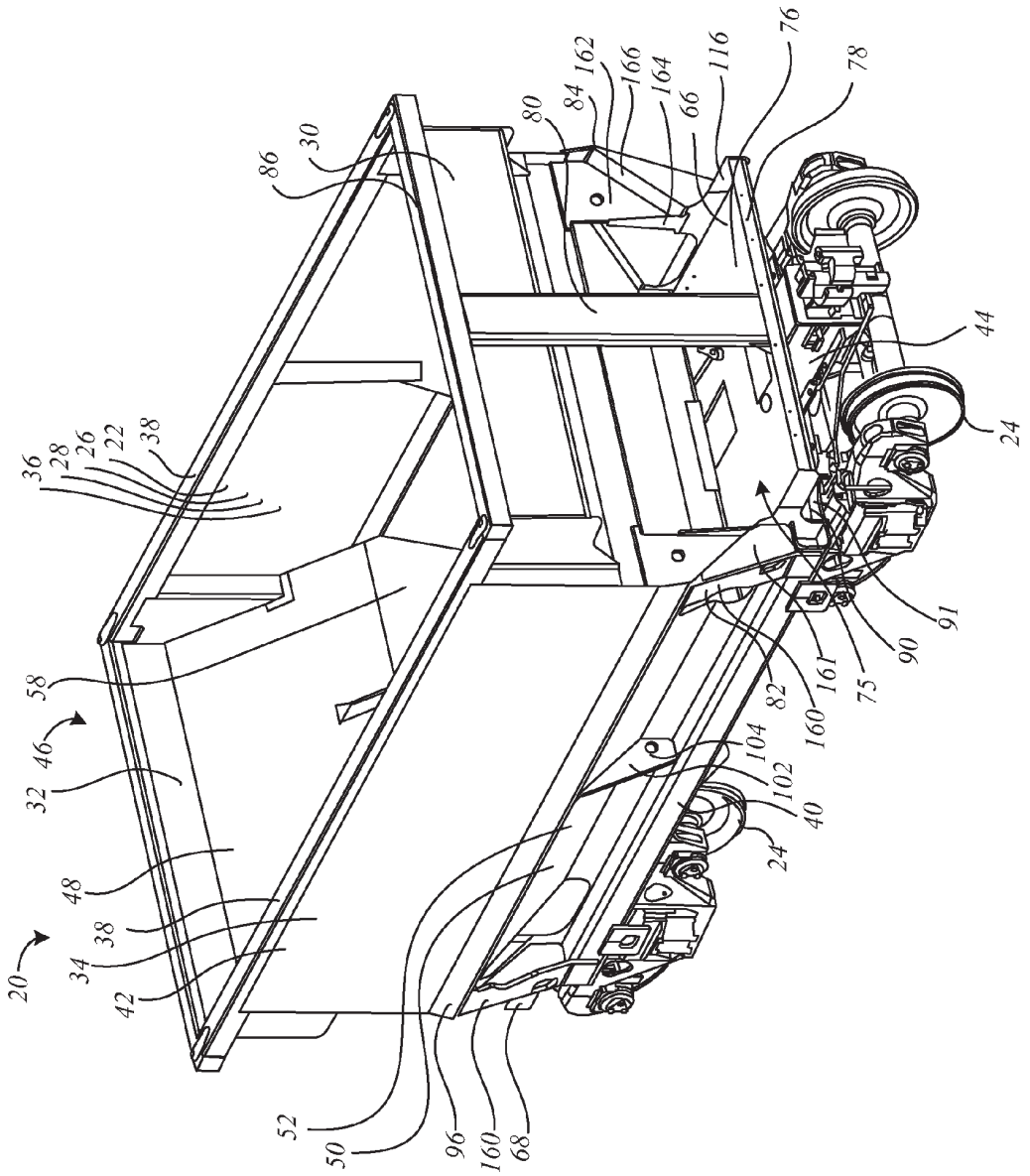

76
78
116
166
164
162
84
80
66
86
30
44
24
36
28
26
22
38
58
46
32
48
38
34
20
42
52
50
96
160
68
91
90
75
161
160
82
104
102
40
24

Figure 1

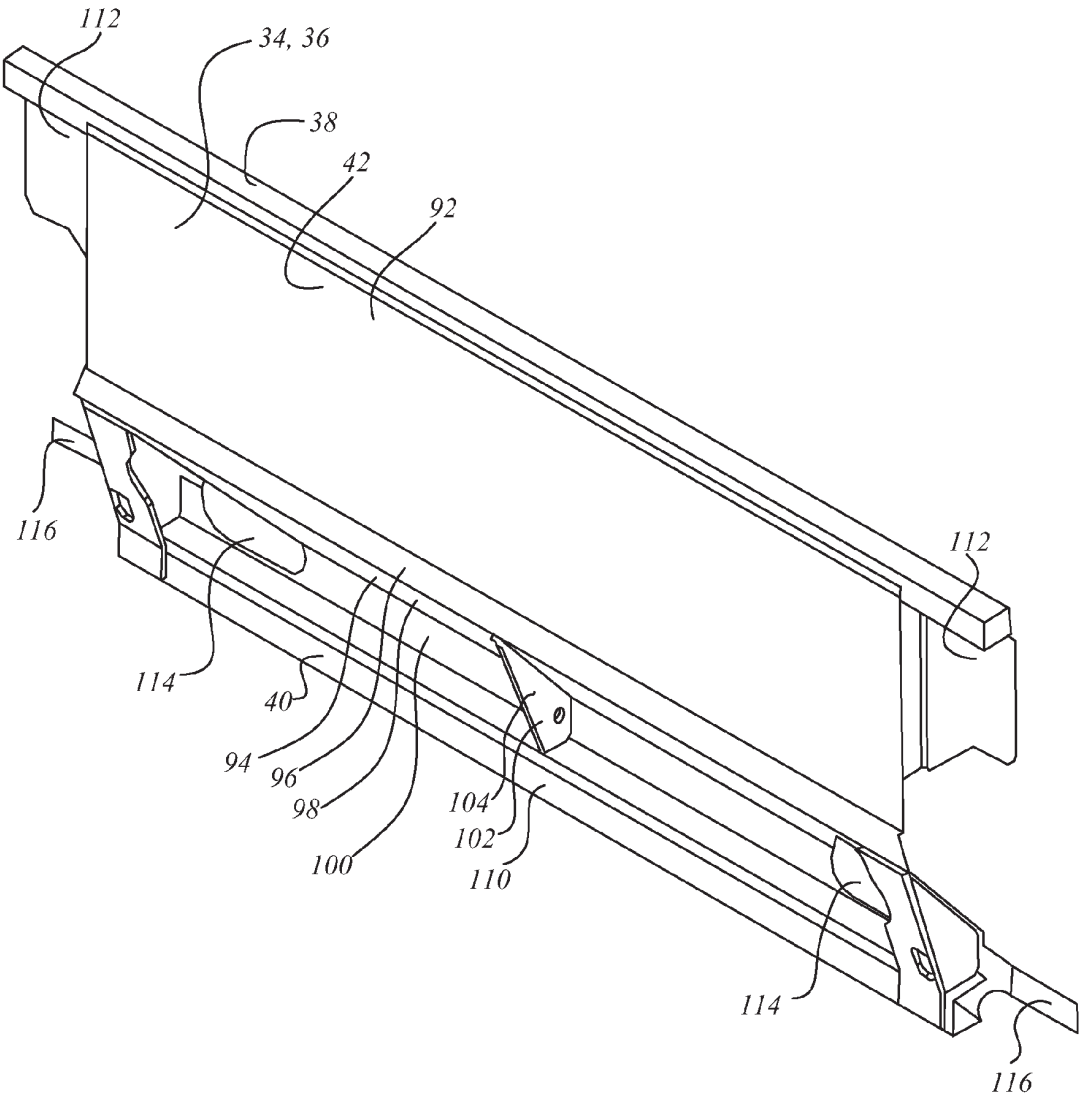


Figure 2a

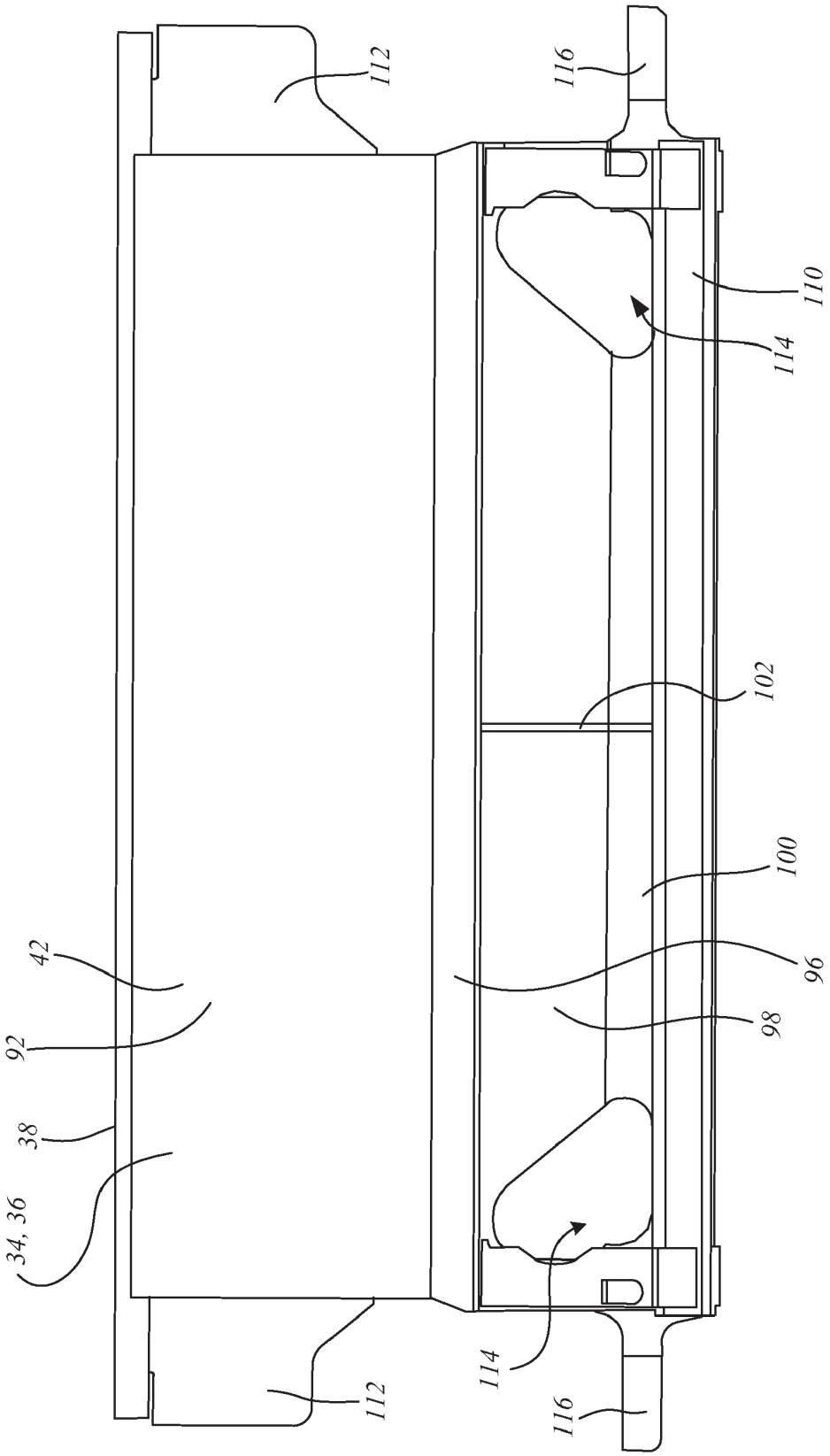


Figure 2b

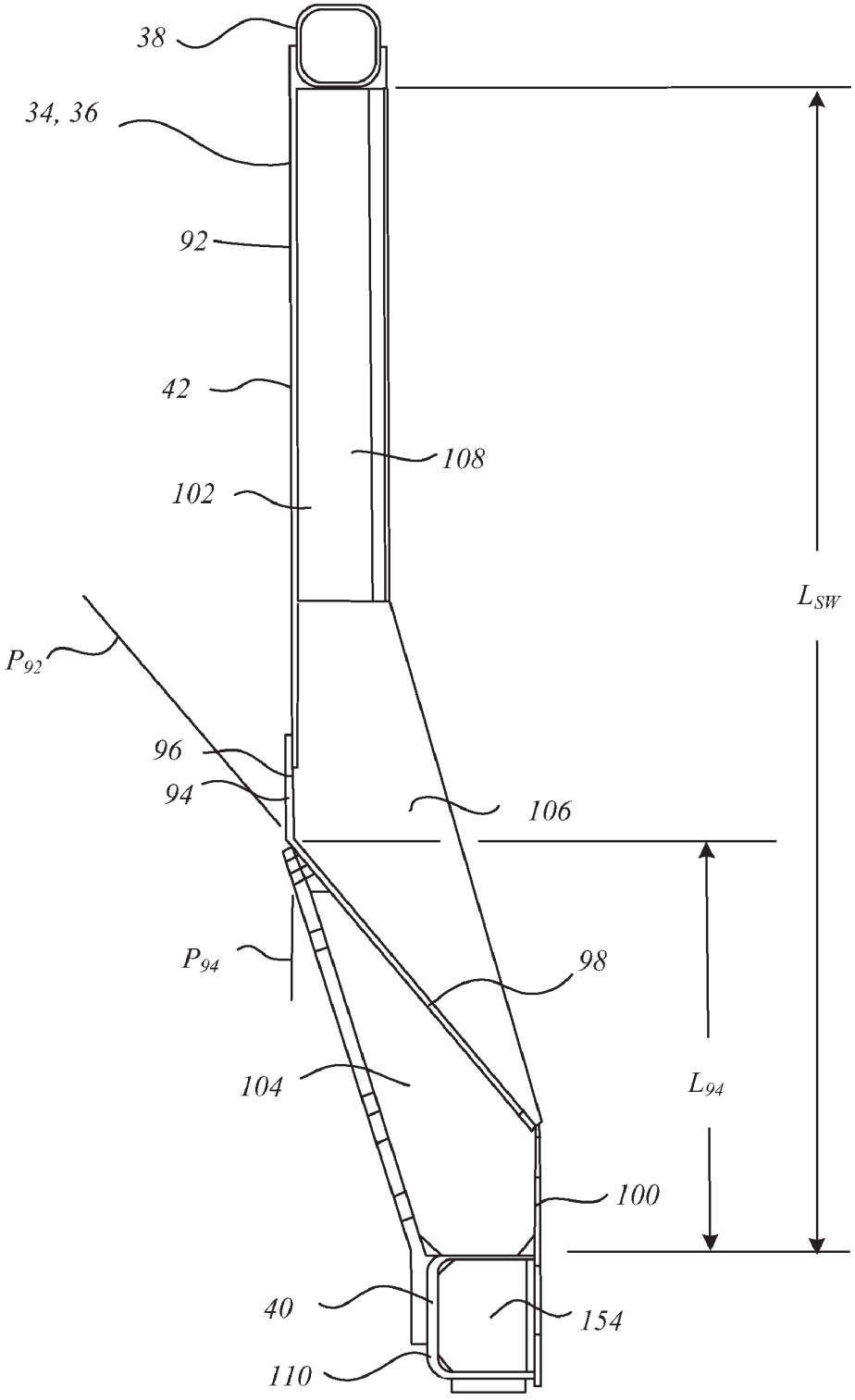

38
34, 36
92
42
108
102
L_{SW}
P_{92}
96
94
106
P_{94}
98
104
L_{94}
100
40
154
110

Figure 2c

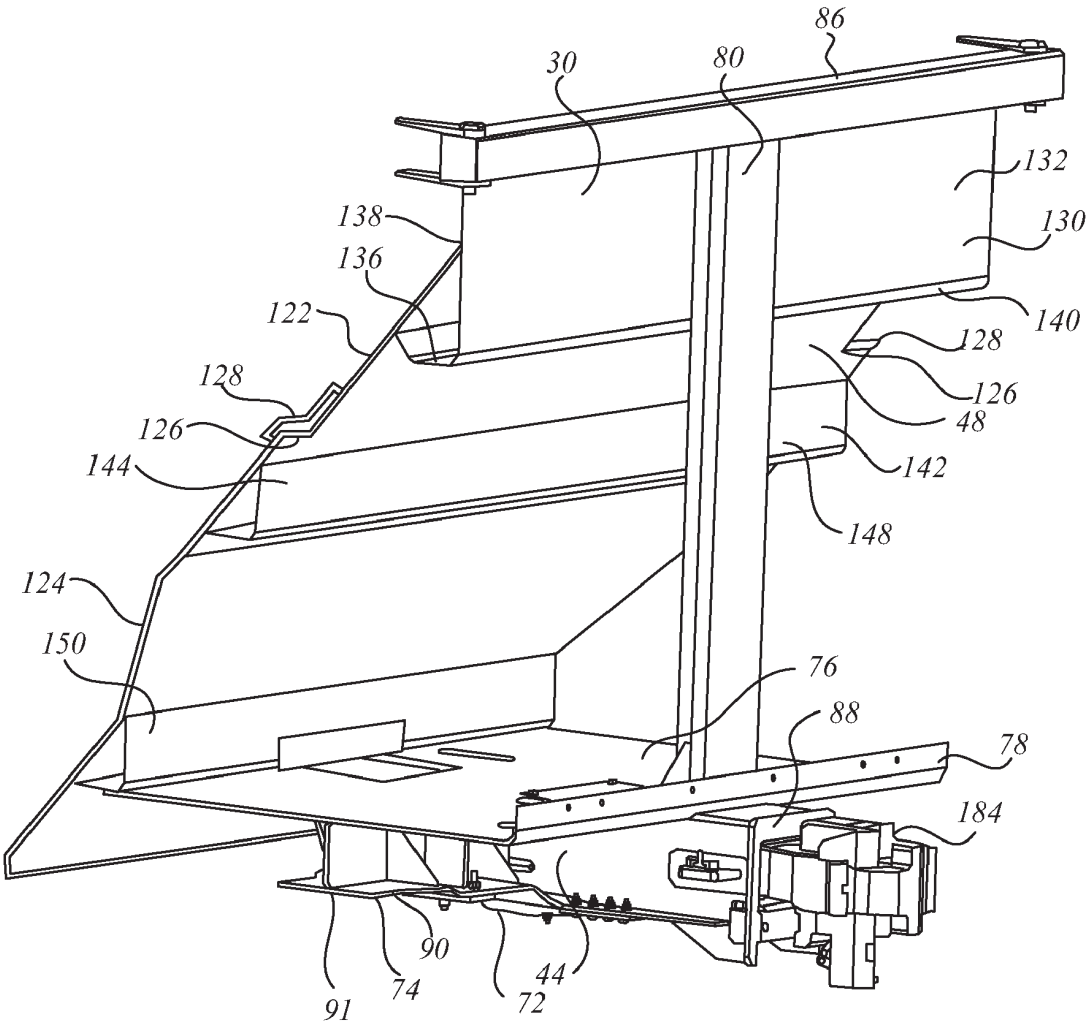

86
30
80
132
138
130
136
122
140
128
128
126
48
126
144
142
148
124
150
76
88
78
184
90
44
91
74
72

Figure 3a

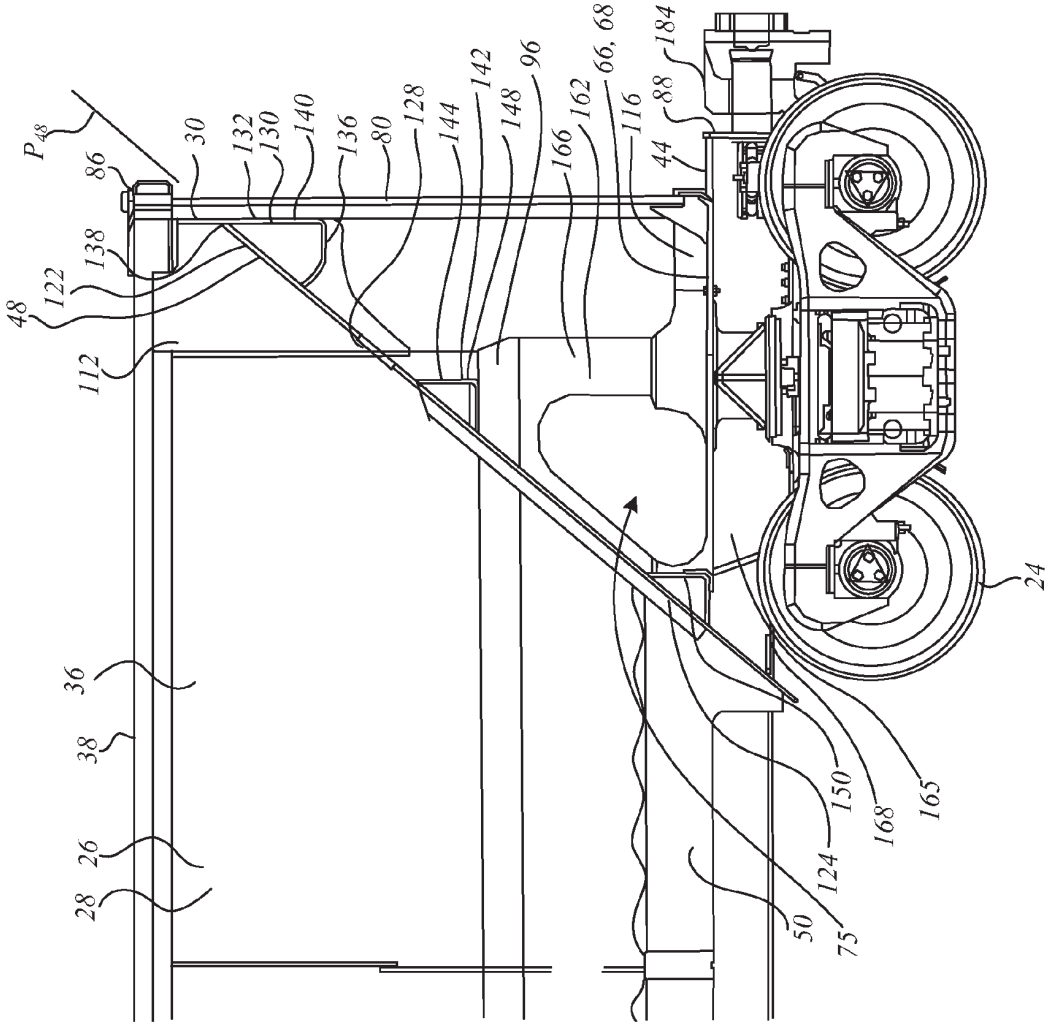

P_{48}
30
132
130
140
136
80
128
144
142
148
96
166
162
66, 68
116
88
184
44
86
138
122
48
112
36
38
26
28
50
124
75
150
168
165
24

Figure 3b

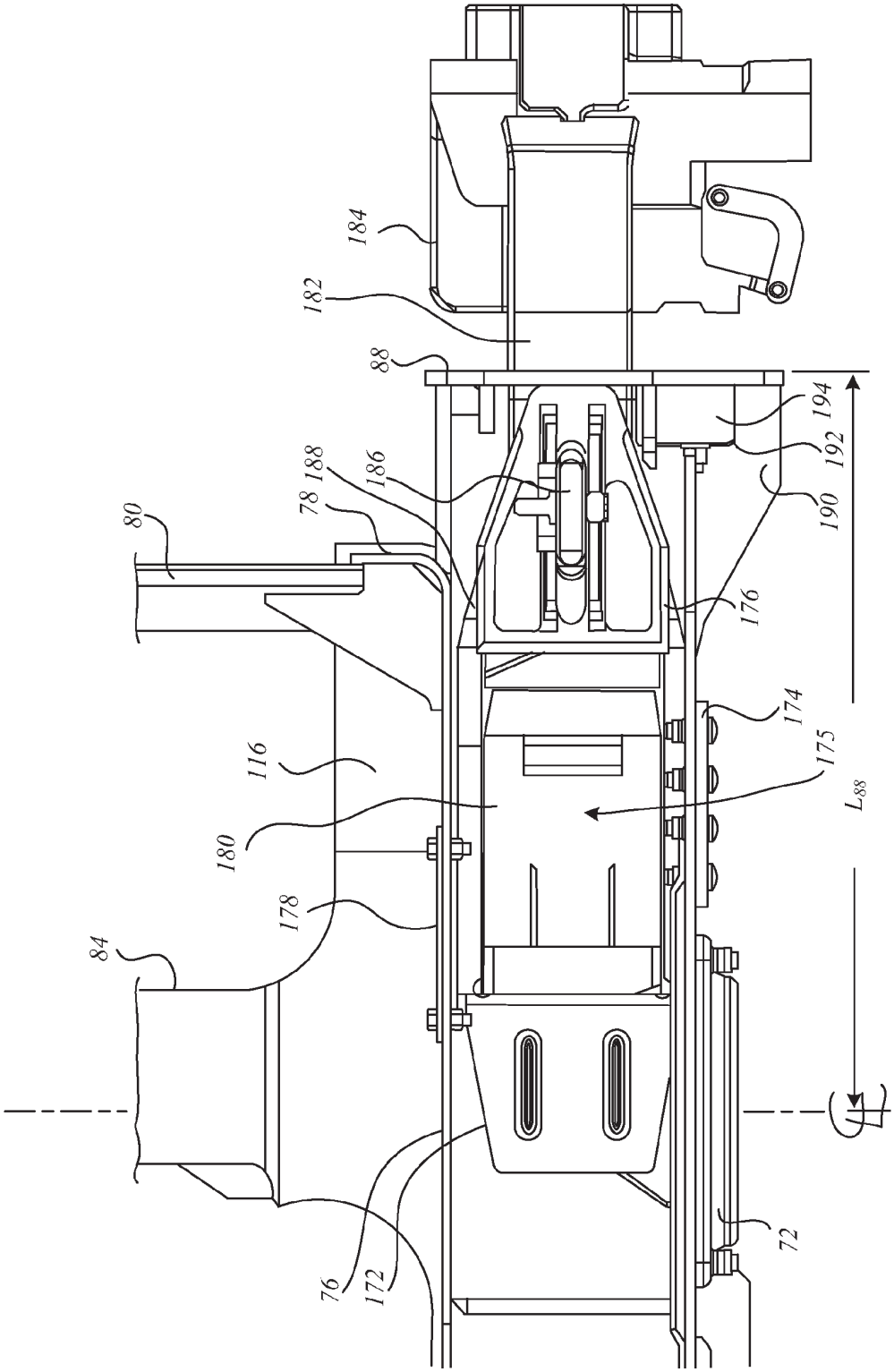

184
182
88
194
192
190
188
186
78
80
176
174
175
116
180
178
84
L_{88}
72
76
172

Figure 3c

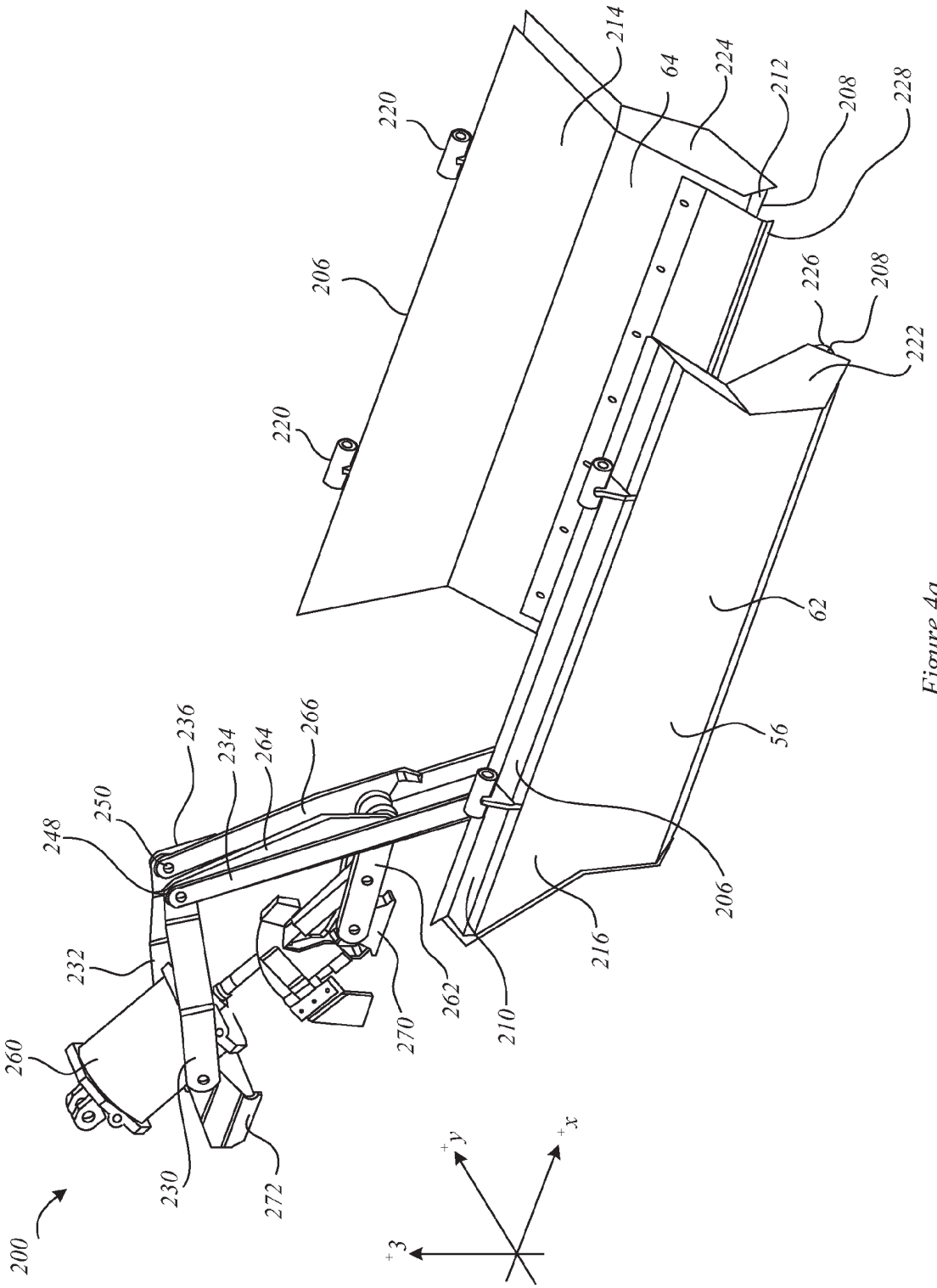

214
64
224
212
208
228
220
206
226
208
222
220
62
56
206
216
210
262
270
272
230
260
232
248
250
236
234
264
266
200
+y
+x
+3

Figure 4a

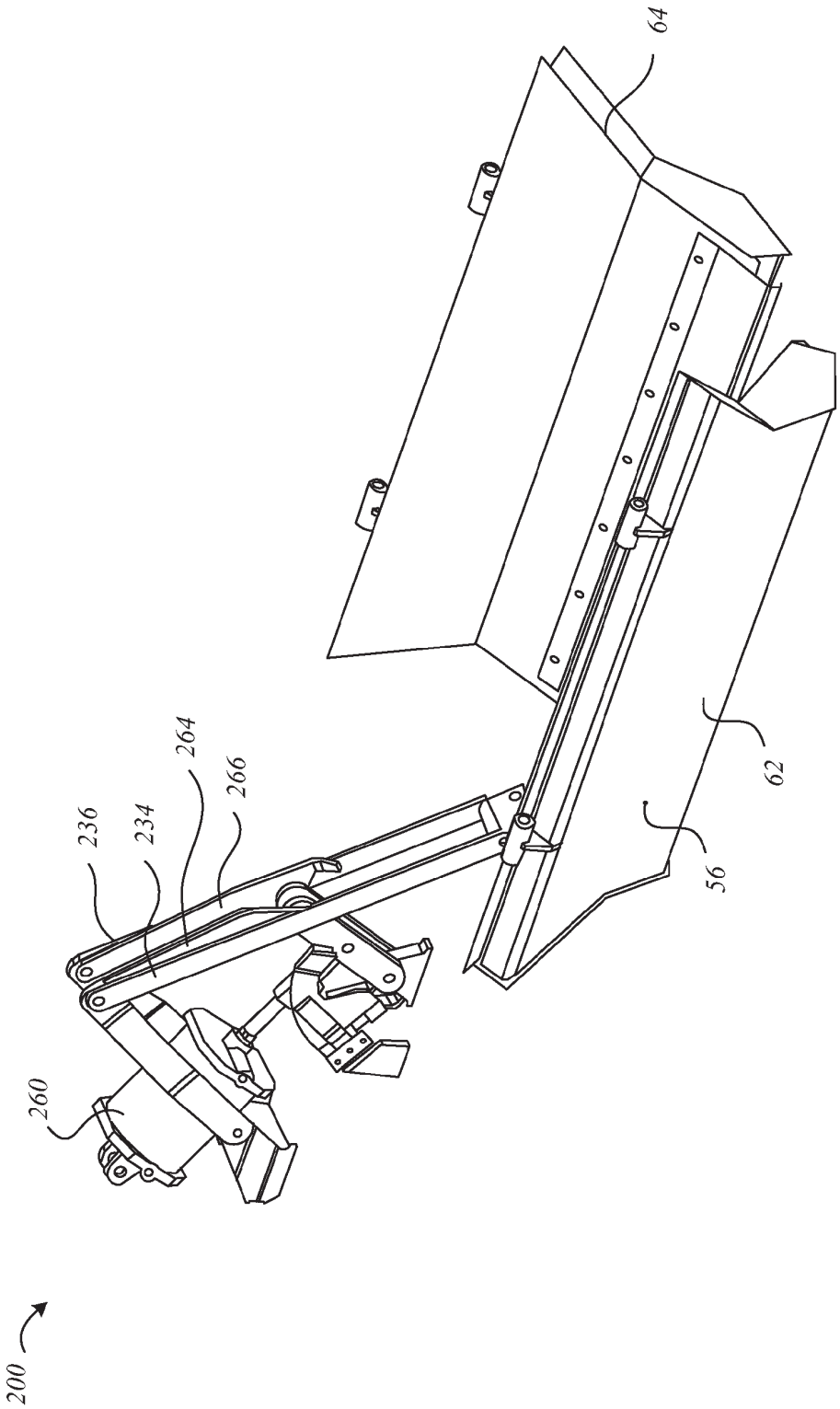


Figure 4b

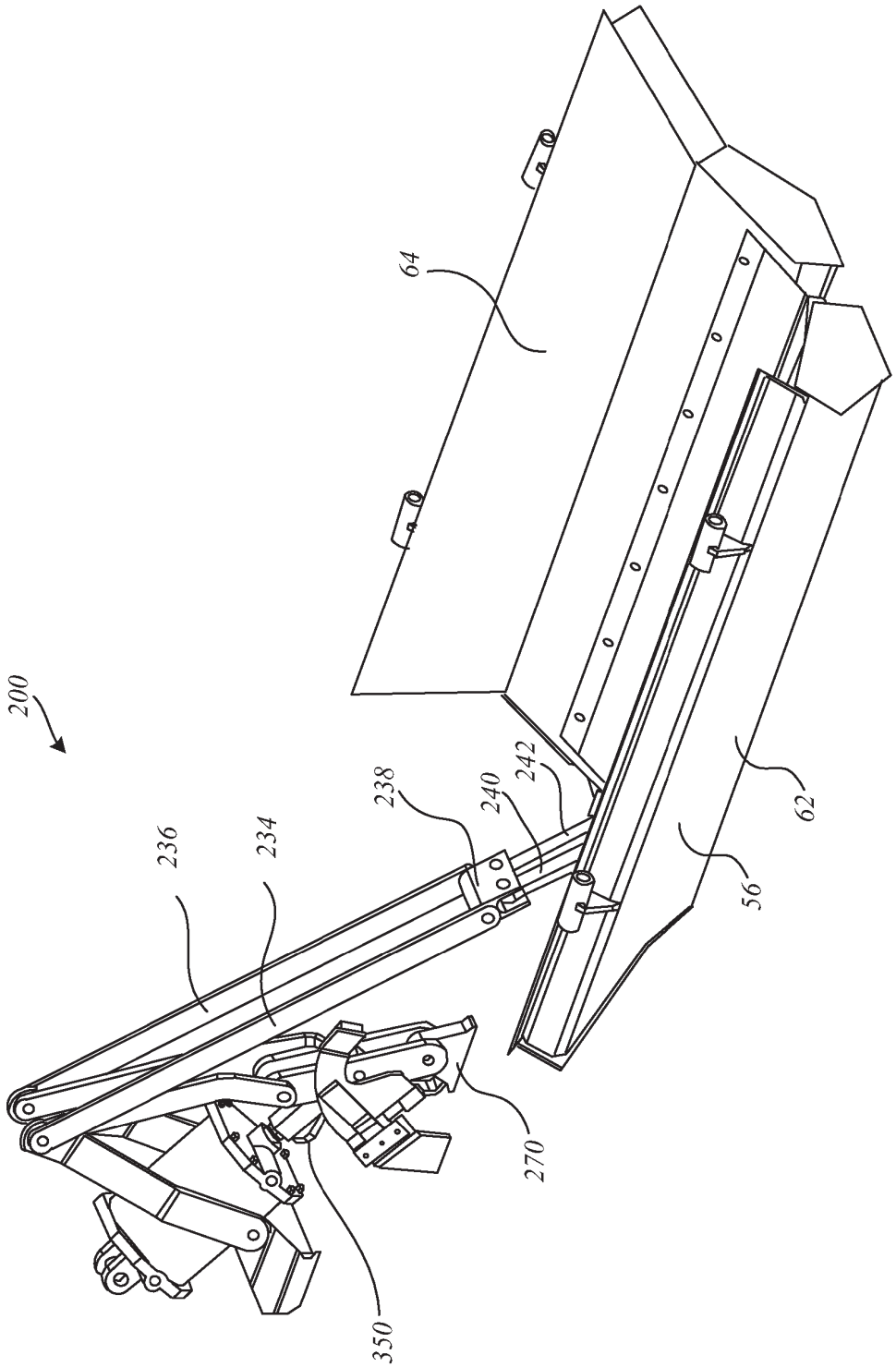


Figure 4c

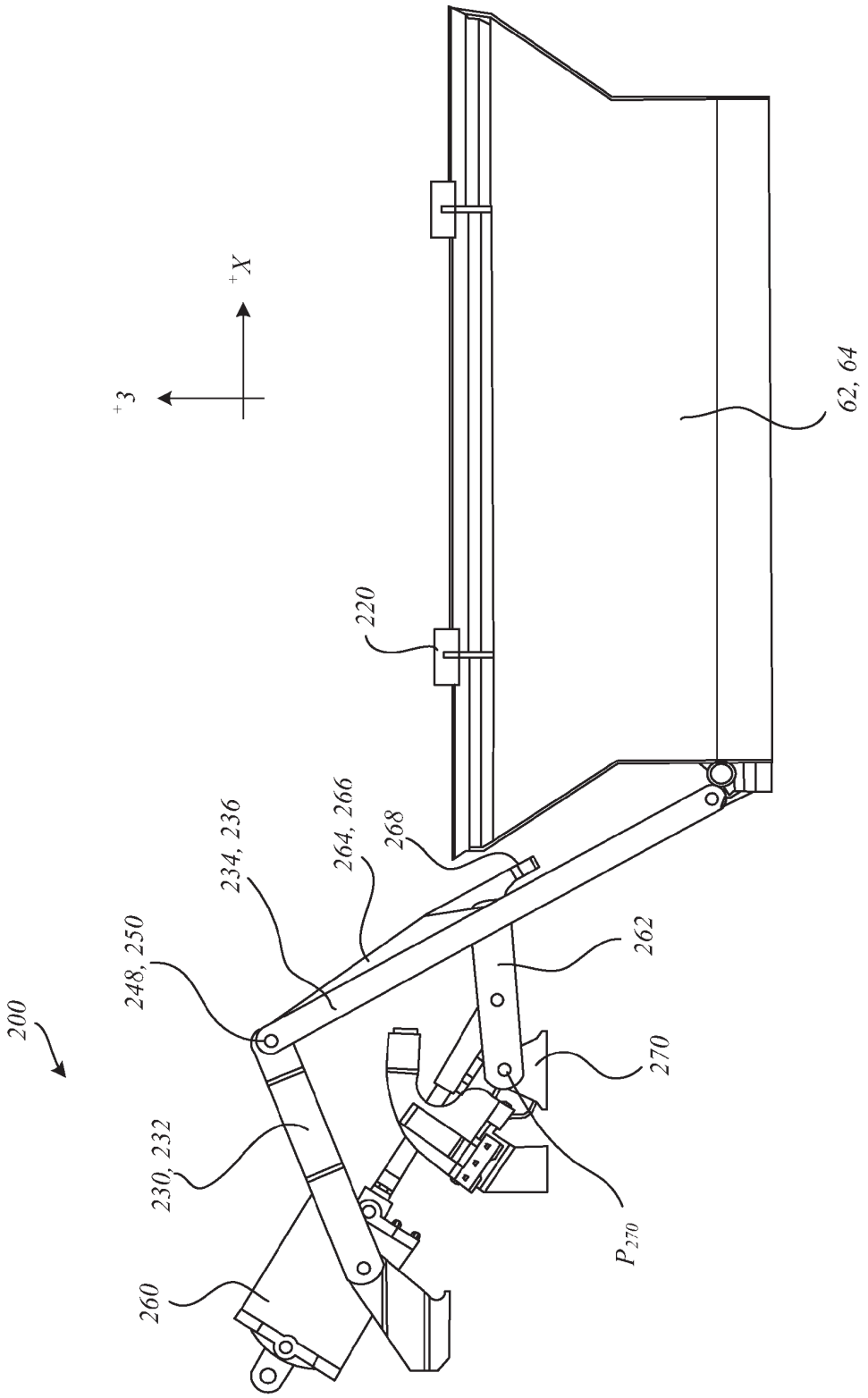

+X
+3
62, 64
220
234, 236
264, 266
268
248, 250
262
200
270
230, 232
P_{270}
260

Figure 5a

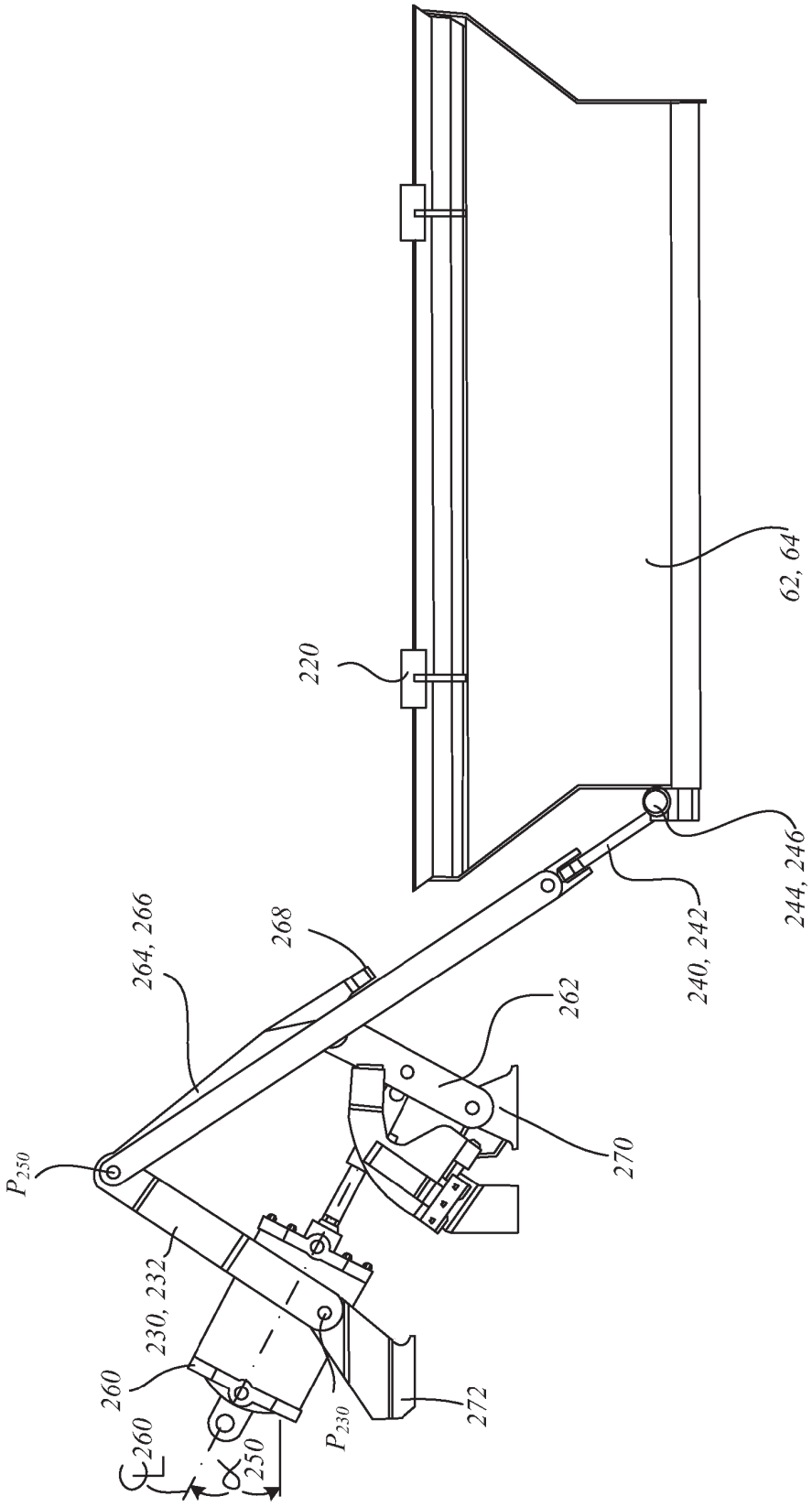

220
62, 64
244, 246
240, 242
268
264, 266
262
270
P_{250}
230, 232
260
260
250
P_{230}
272

Figure 5b

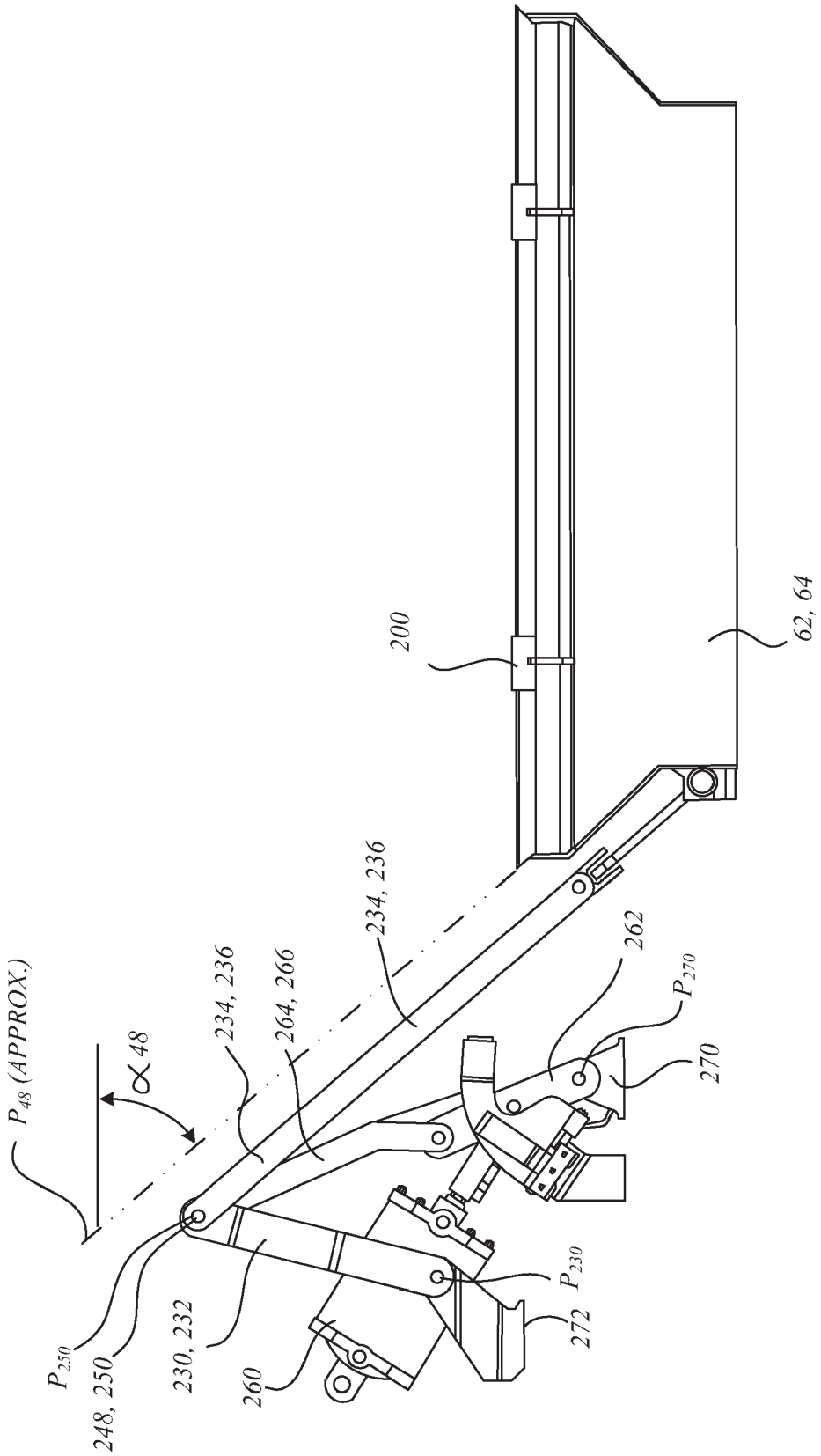

200
62, 64
234, 236
262
P_{270}
270
P_{48} (APPROX.)
48
234, 236
264, 266
P_{230}
272
P_{250}
248, 250
230, 232
260

Figure 5c

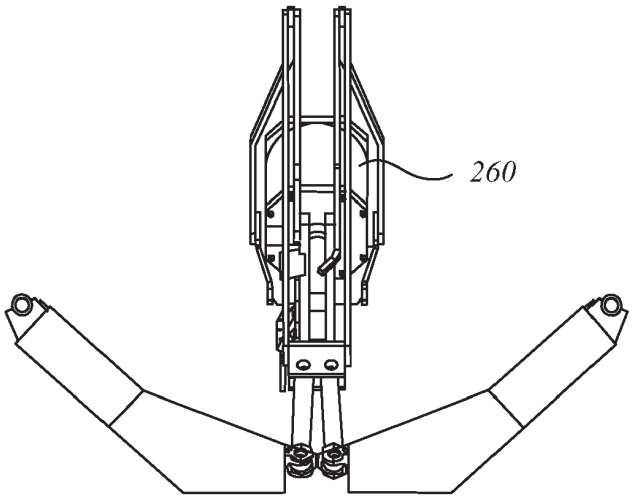


Figure 6c

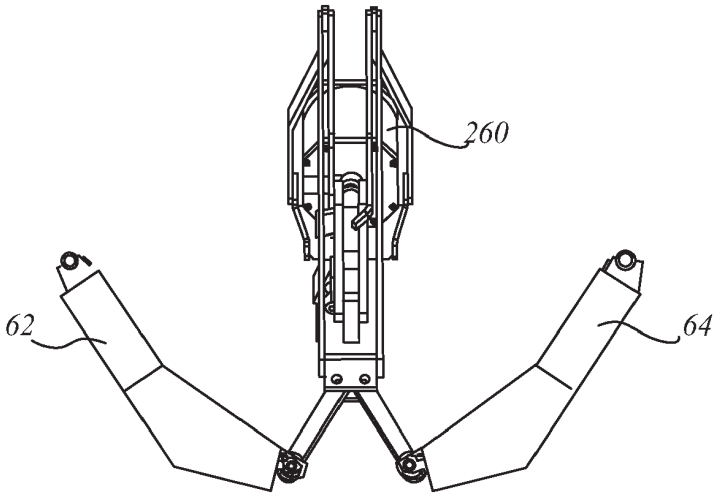


Figure 6b

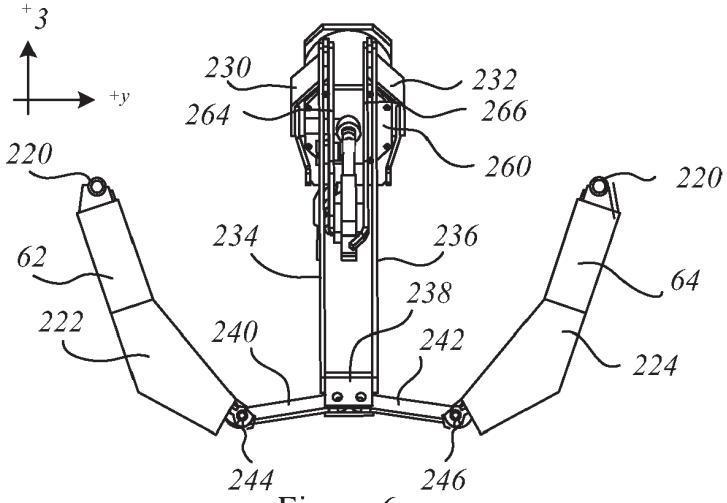


Figure 6a

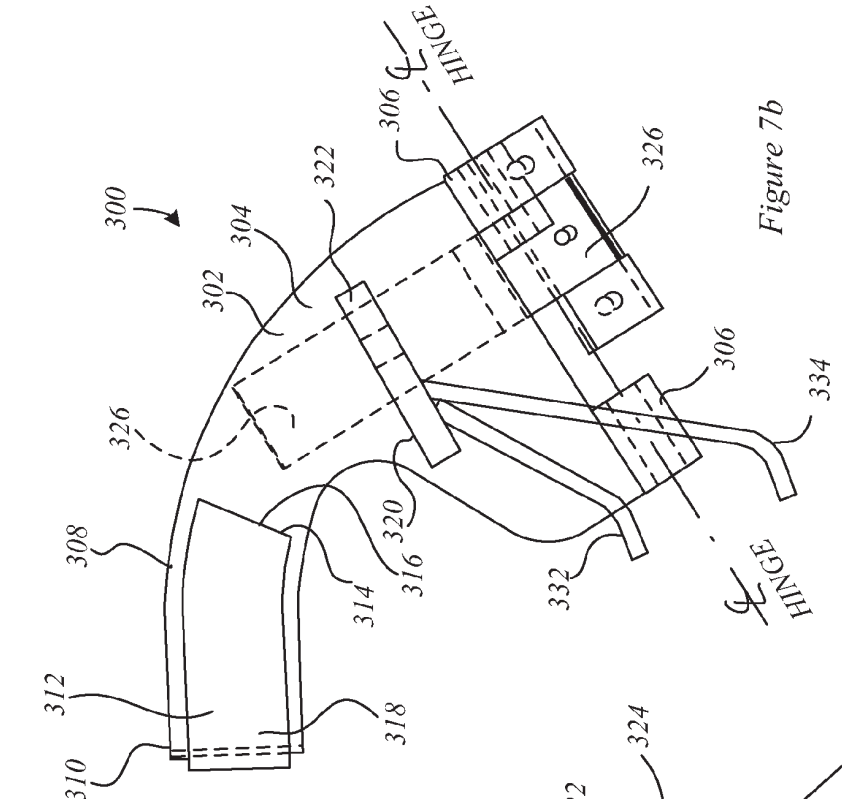


Figure 7b

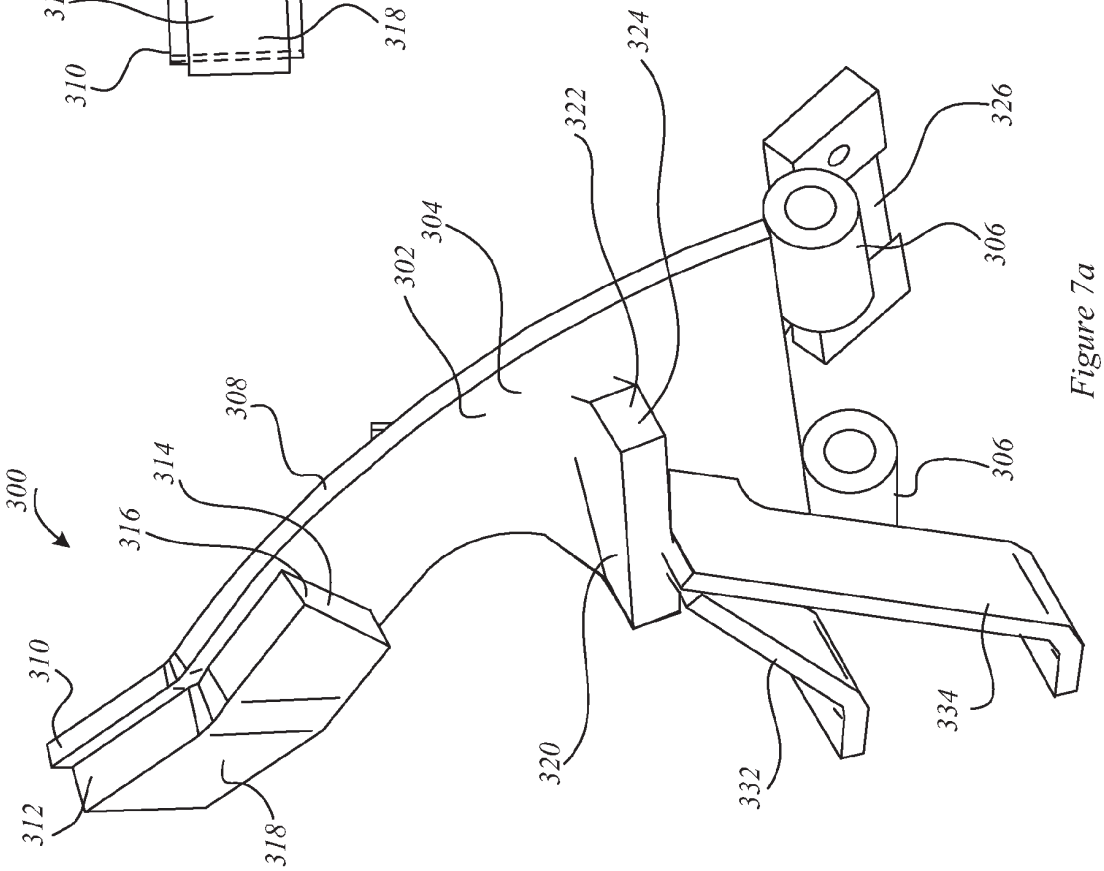


Figure 7a

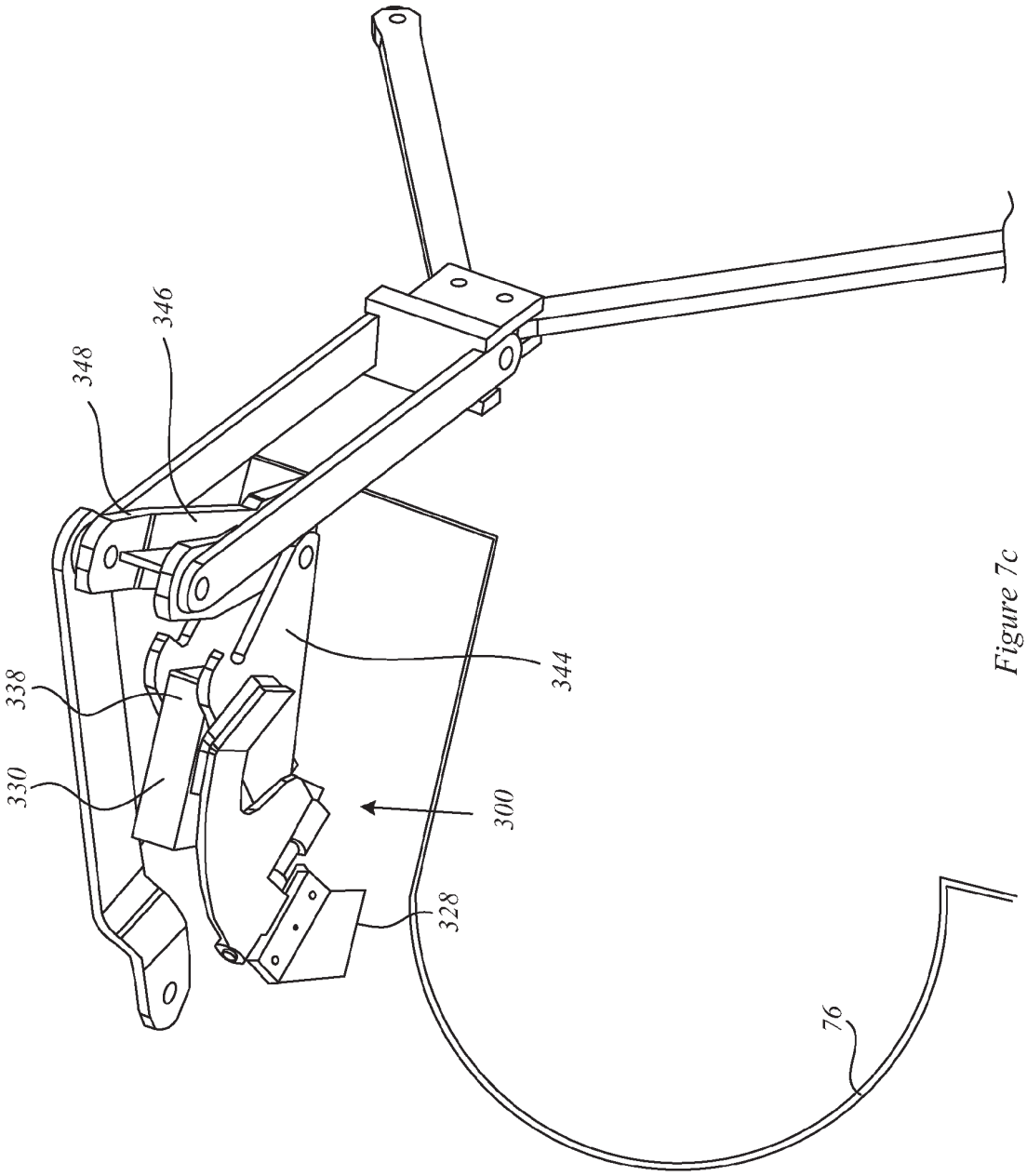


Figure 7c

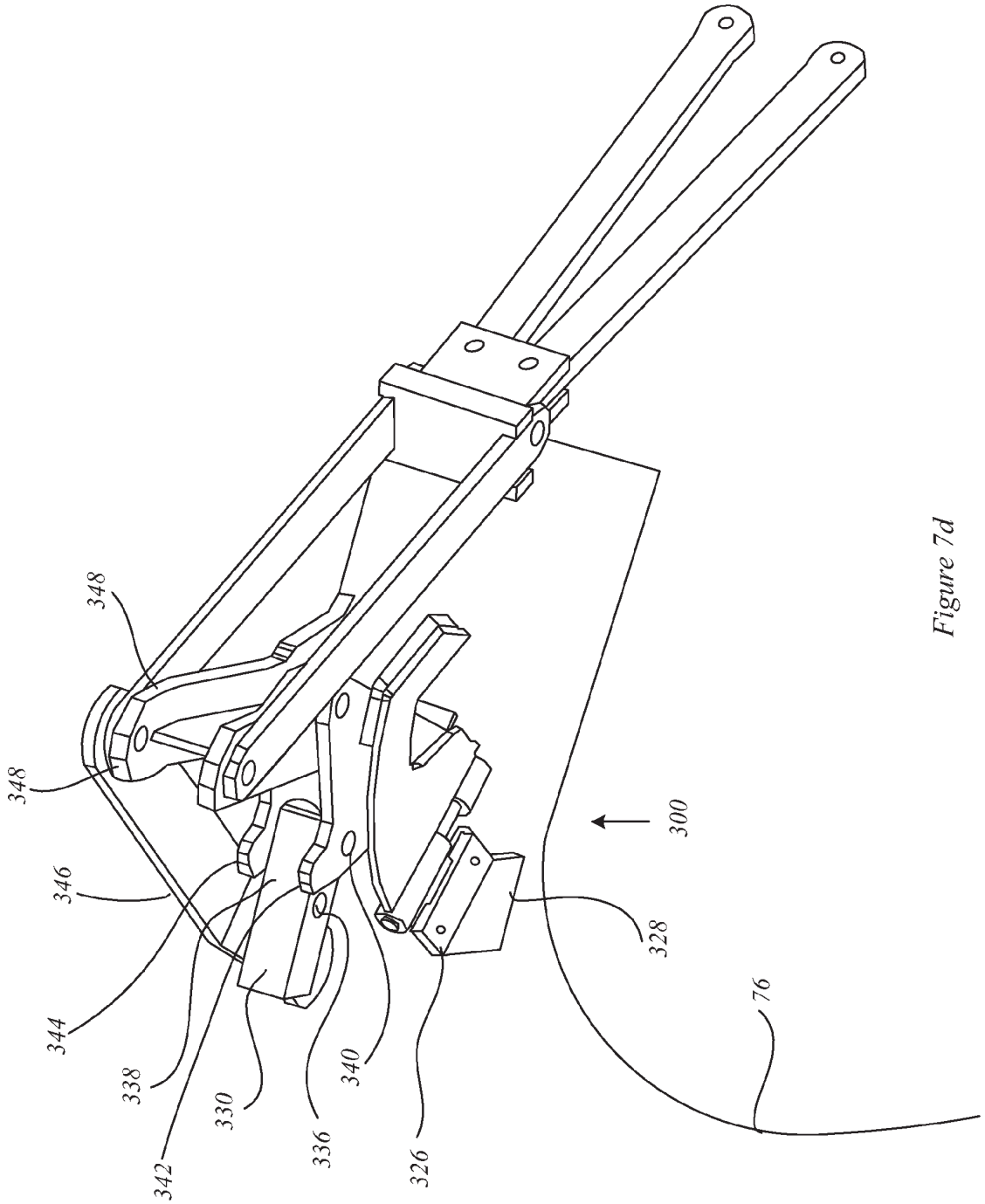


Figure 7d

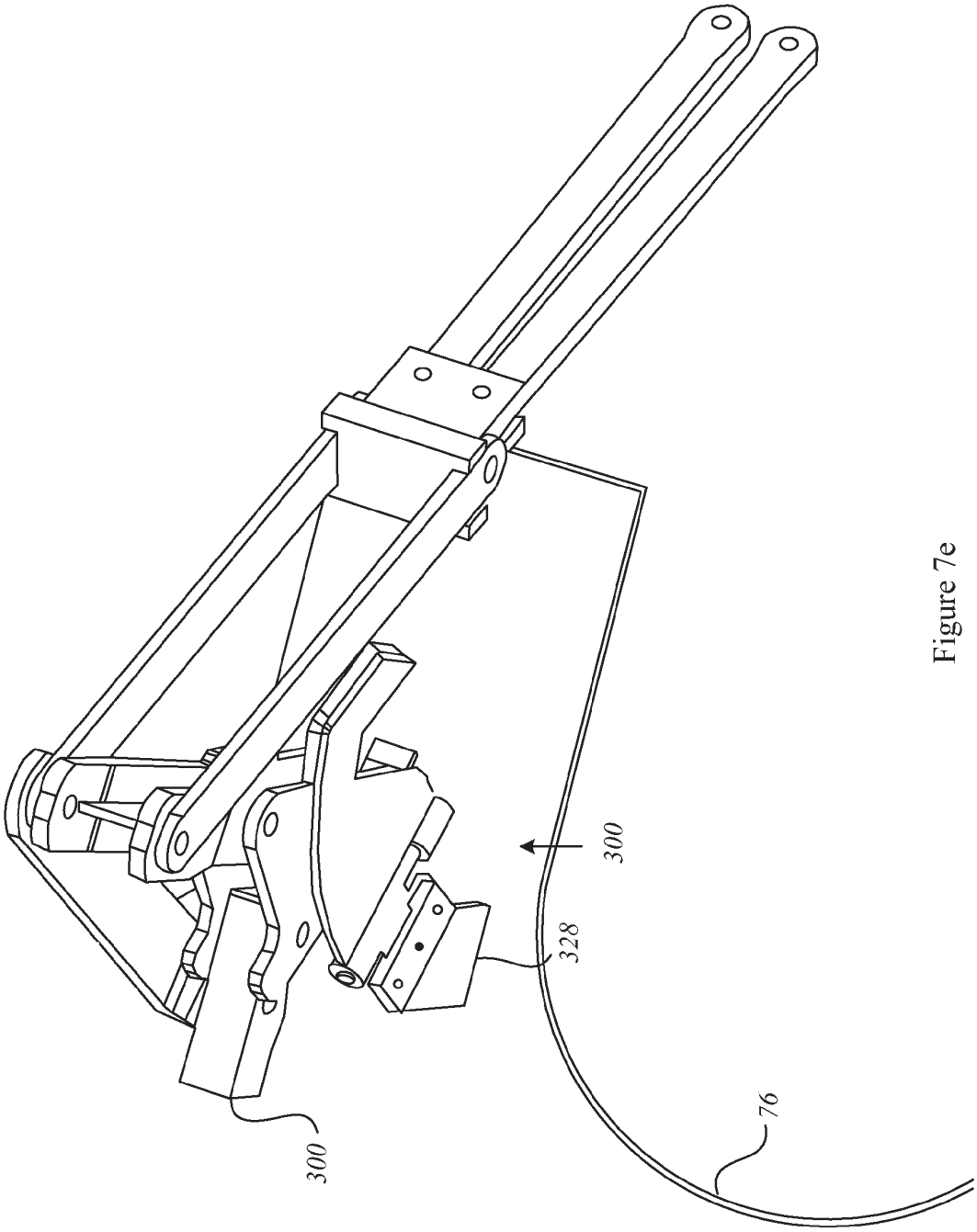


Figure 7e

RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR

This application claims priority under 35 USC 119 on the basis of Canadian Patent Application Serial Number 2,678,447, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 11, 2009, the specification of which is incorporated herein by reference. This application also claims priority to Canadian Patent Application Serial Number 2,678,605.

FIELD OF THE INVENTION

This invention relates to the field of railroad freight cars, and, in particular to rail road gondola cars such as may employ bottom unloading gates or doors.

BACKGROUND

There are many kinds of rail road cars for carrying particulate material, be it sand or gravel aggregate, plastic pellets, grains, ores, potash, coal or other granular materials. Many of those cars have an upper opening, or accessway of some kind, by which the particulate is loaded, and a lower opening, or accessway, or gate, or door by which the particulate material exits the car under the influence of gravity. While the inlet opening need not necessarily have a movable gate, the outlet opening requires a governor of some kind that is movable between a closed position for retaining the lading while the lading is being transported, and an open position for releasing the lading at the destination. The terminology "flow through" or "flow through rail road car" or "center flow" car, or the like, may sometimes be used for cars of this nature where lading, typically particulate lading, is introduced at the top, and flows out at the bottom.

Discharge doors for gondola cars or other bottom dumping cars may tend to have certain desirable properties. First, to the extent possible it is usually desirable for the door opening to be large so that unloading may tend to be relatively fast, and for the sides of any unloading chute to be relatively steep so that the particulate will tend not to hang up on the slope. Further, to the extent that the door can be large and the slope sheets steep, the interior of the car may tend to have a greater lading volume for a given car length. Further still, any increase in lading achieved will tend to be at a relatively low height relative to Top of Rail (TOR) and so may tend to aid in maintaining a low center of gravity. A low center of gravity tends to yield a better riding car that is less prone to derailment, and perhaps less prone to cause as much wear or damage to tracks.

For a given length of car, hopper volume, and hence overall car volume, can be maximized by reducing the proportion of the length of the car occupied by the trucks, and occupied by the door opening drive mechanism. Furthermore, where the lading to be carried by the car is of greater than usual density, it may often be helpful for the truck center length to be relatively short such that the length of the span between the trucks is smaller, and the weight of the structure may be correspondingly decreased relative to the maximum permissible gross weight on rail for the car. In some instances, as with iron ore or other high density lading, that truck center distance may be very short.

It may also be that in some circumstances ore cars are used in quasi-permanent sets that form a unit train. The unit train may tend to follow a single route for substantially its entire operational service life. In the case of an ore car, that operational route may be from a mine or concentrator facility, at

which the cars receive the lading; to a discharge facility, whether a mill or a break of bulk terminal at a port. In these circumstances the line may be owned by the mine or mill, and the cars may not necessarily be used for interchange service. To the extent that they are not used for interchange service they may not necessarily comply with all AAR standards. The cars may have short, possibly non-standard draft sills, draft gear, and couplers, or a combination thereof.

The cars may have tightly limited space envelopes over the end shear plates, and yet these spaces may nonetheless be intended to accommodate, for example, the brake reservoir and pneumatic gear for operating the gondola discharge doors.

SUMMARY OF THE INVENTION

In an aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a door movable between a closed position for retaining lading and an open position for permitting egress of lading. The hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has at least a first end slope sheet inclined downwardly in the lengthwise direction toward the door. There is a linkage connected to the door. The linkage is oriented lengthwise with respect to the car. A drive is connected to the linkage. The drive is operable to move the linkage and thereby to urge the door to a closed position. The linkage is movable from a first position corresponding to the open position of the door to a second position corresponding to the closed position of the door. The linkage includes at least a drag link. When the linkage moves from the first to the second position one of (a) the overall motion from the first to the second position includes displacement of the drag link in a direction having a predominant component of motion parallel to the first end slope sheet; and (b) the motion of the drag link is at least instantaneously parallel to the first end slope sheet.

In another feature of that aspect of the invention the linkage includes a first pivot arm pivotally connected to a datum structure at a first pivot connection. The drive is also mounted to the datum structure. The linkage includes a second pivot arm pivotally connected to the datum structure at a second pivot connection. The second pivot arm has the door mounted thereto. The first pivot arm has a second connection distant from the first pivot connection. The second pivot arm has a second connection distant from the second pivot connection. A mechanical transmission is mounted between the second connection of the second pivot arm and the second connection of the first pivot arm. The mechanical transmission includes the drag link. The drive is connected to move the first pivot arm, and, in moving from the first position to the second position, each position of the first pivot arm being associated with a unique position of the drag link. In a further feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. Each second pivot arm has a respective second con-

nection distant from the respective second pivot connection. A mechanical transmission is mounted between the respective second connections of the second pivot arms and the respective second connections of the first pivot arms. The drag link is a left hand drag link, and the mechanical transmission includes a mated parallel right hand drag link. The left and right hand drag links each have a first end mounted to one of the respective second connections of the first pivot arms. The left and right hand drag links have second ends yoked together distantly from the first ends. The transmission member includes left and right hand slave links extending between and connecting the second ends of the drag links to the second connections of the second pivot arms respectively.

In still another feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. The left and right hand pivot arms co-operate to define a bifurcated lever straddling the drive. In yet another feature, the drive includes an actuating cylinder having an axially reciprocating member, the axially reciprocating member being inclined relative to horizontal. In still another feature the drag link lies between the actuating cylinder and the first end slope sheet of the hopper. In another feature the railroad hopper car includes a first end section, the first end section includes a draft sill and a substantially horizontal shear plate mounted over the draft sill, the drive includes an actuating cylinder having an axis of reciprocation lying in a central vertical-lengthwise plane of the car, the actuating cylinder is mounted above the shear plate, the first end slope sheet at least partially overhangs the actuating cylinder; and the drag link is located between the actuating cylinder and the first slope sheet.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. The car includes structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. A door operating linkage is connected to the gate, the door operating linkage being oriented lengthwise with respect to the car. An actuating cylinder connected to drive the door operating linkage, the actuating cylinder also being oriented to act lengthwise with respect to the car, the actuating cylinder having an axis of reciprocation. The axis of reciprocation being tilted such that displacement of the actuating cylinder includes a vertical component of motion.

In another feature of that aspect of the invention, the hopper car includes an end section mounted over one of the trucks, the end section includes a substantially horizontal shear plate, and the actuating cylinder is mounted on a pedestal mounted to the shear plate, the pedestal including an inclined mounting for the cylinder. In a further feature, the railroad hopper car has a longitudinal-vertical central plane, and the axis or reciprocation lies in the longitudinal-vertical plane. In a still further feature, the hopper includes at least a first end slope sheet extending longitudinally and being inclined longitudinally inboard and downwardly toward the gate, and at least part of the actuating cylinder is overhung by at least part of the first end slope sheet. In a yet further feature, the hopper car includes an end section having a substantially horizontal shear plate mounted over a draft sill. The hopper includes a first end slope sheet, the first end slope sheet at least partially overhanging the horizontal shear plate. The actuating cylinder is mounted above the shear plate, centrally aligned over the draft sill. The actuating cylinder is at least partially overhung by the first end slope sheet. In still yet another further feature the first slope sheet is substantially planar and has a first angle of inclination relative to horizontal. The actuating cylinder is inclined longitudinally inboard downwardly, and is inclined at a second angle. The second angle lies between horizontal and the first angle. In yet another feature the car has an underframe and the door operating linkage includes a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, the first pivot linkage being a first pivot arm constrained to pivot on an axis of rotation oriented horizontally cross-wise relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and includes at least the gate. The third linkage component includes a drag link element connected to the first pivot arm, the drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator. In still another feature the main pivot connection of the first pivot arm to the first linkage component is located lower than the actuating cylinder. In yet still another feature, the drag link element is connected to the first pivot arm at a distal pivot connection relative to the main pivot connection, and, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection.

In another aspect there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. It has first and second end sections to which the hopper is mounted, the first and second end sections being mounted to respective first and second railroad car trucks for rolling motion along railroad tracks in a lengthwise direction of the car. There is a door operating linkage connected to the gate, the door operating linkage being oriented lengthwise with respect to the car and connected. An actuating cylinder is connected to drive the door operating linkage. The actuating cylinder is also oriented to act in a lengthwise extending plane with respect to the car. The actuating cylinder has an axis of reciprocation. The door operating linkage includes a first pivot arm pivotally mounted to the first end section at a first pivot connection. There is a mechanical transmission connected between the first pivot arm and the gate. The mechanical transmission includes at least a drag link movably connected to the first pivot arm at a location distant from the first pivot connection. The first pivot connection is lower than the actuating cylinder as seen when viewing the first end section in side view.

In another feature of that aspect of the invention, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot con-

nection and the distal pivot connection. In still another feature, the actuating cylinder drives an intermediate lever that is connected to drive the first pivot arm.

In another aspect of the invention there is a rail road hopper car. It has a hopper carried between a pair of trucks, the hopper having first and second upstanding sidewalls running lengthwise therealong. The hopper has a lower discharge and convergent slope sheets giving onto the discharge. The rail road car has a side sill and a top chord. The first upstanding sidewall extends from the side sill to the top chord. The first upstanding sidewall has a predominantly upwardly running sidewall stiffener mounted thereto. The sidewall stiffener is located at a longitudinal station intermediate the trucks. The first upstanding sidewall has a first region, the first region being a lower region thereof. The first upstanding sidewall has a second region. The second region is an upper region thereof. The sidewall stiffener has a first portion, the first portion being a lower portion thereof. The first portion is mounted to the first region of the first upstanding sidewall. The sidewall stiffener has a second portion, the second portion being an upper portion thereof. The second portion is mounted to the second region of the upstanding sidewall. The first portion of the first upstanding sidewall stiffener is laterally outboard of the first region of the first upstanding sidewall. The second portion of the sidewall stiffener is laterally inboard of the second region of the first upstanding sidewall. The sidewall has a continuous section between the first and second regions thereof. The sidewall stiffener has web continuity between the first and second portions thereof.

In a feature of that aspect of the invention, the first and second portions of the sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and the stiffener has vertical web continuity through the transition portion. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof. The hopper includes first and second sloped side sheets. The first sloped side sheet meets the first sidewall at the transition portion. In another feature, the first sidewall has an overall height from the side sill to the top chord, L, and the transition is located a distance above the side sill that is in the range of ¼ to ⅔ L. In a still further feature the first sidewall has an overall height from the side sill to the top chord, L, and the first sloped sheet meets the transition at an height that is in the range of ¼ to ⅔ L above the side sill.

In a further aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge having a bottom discharge governor movable between a closed position for retaining lading and an open position for permitting egress of lading. The car has structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has a door operating linkage oriented lengthwise with respect to the car. There is an actuating cylinder also oriented to act in a lengthwise extending plane with respect to the car, the actuating cylinder being connected to drive the door operating linkage. The door operating linkage includes a pair of first and second linkage members co-operably mounted to either transverse side of the actuating cylinder, whereby the actuating cylinder is bracketed by the linkage members.

In another feature of that aspect of the invention, the car has an underframe and the linkage is a closed loop bar linkage in which there is a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, and which includes the first and second linkage members, the first and second linkage members being a matched pair of left and right hand pivot arms constrained to pivot on a common axis of rotation relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and which includes at least one pivotally mounted door assembly defining the bottom discharge governor. The third linkage component includes a drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator.

In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. Displacement of the third linkage component associated with motion of the door assembly between the open position is predominantly in a direction generally parallel to the end slope sheet. In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. During at least an instantaneous portion of motion of the third linkage component while the door assembly is in a position between the open position and the closed position the third linkage component moves parallel to the end slope sheet. In still another feature the third linkage component includes at least a first element and a second element mounted thereto. The first element is pivotally mounted to the first linkage component, and is constrained to move in a lengthwise-vertical plane relative to the first linkage component. The second element has a first connection to the first component the first connection being a pivot connection. The second element has a second connection to the fourth linkage component, the second connection having at least one degree of freedom of motion. The second element is constrained always to be coplanar with the first connection, the second connection, and the main pivot connection. In yet still another feature, the bottom discharge governor includes a door. The actuating cylinder is connected to drive the door operating linkage through a lever assembly. The lever assembly has an overcenter lock that is operable to prevent release of the bottom gate to the open position when the actuating cylinder is inactive. In yet a further feature, motion of the first pivot linkage occurs in a longitudinal-vertical plane. The second pivot linkage moves in a plane generally cross-wise to the longitudinal-vertical plane. In still a further feature the main pivot connection is beneath the actuating cylinder when the hopper car is seen in side view. In again another feature one of (a) the main pivot is beneath the drag link element; and (b) the actuating cylinder is between the main pivot and the drag link element. In a yet still further feature, the hopper includes at least a first end slope sheet, and the bottom discharge governor includes a door. The first end slope sheet is inclined longitudinally

downwardly and inboard toward the door. The drag link element is inclined on a slope predominantly parallel to, and adjacent to, the first end slope sheet. The actuating cylinder is oriented along the lengthwise direction, and is also tilted longitudinally downwardly and inwardly toward the door.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper carried by railroad car trucks for motion in a lengthwise direction of the car along railroad tracks. The hopper has a bottom discharge. The bottom discharge has a door movable between a closed position for retaining lading and an open position for permitting egress of lading. A mechanical transmission is connected to the door. The mechanical transmission is oriented lengthwise with respect to the car. A door actuator is connected to the mechanical transmission and is operable to urge the door from the open position toward the closed position, the door actuator being oriented to reciprocate in a first direction. The hopper car has a first lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. The hopper car has a second lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator.

In another feature of that aspect of the invention, the car has a central lengthwise-vertical plane, the door actuator is positioned to reciprocate in the central lengthwise-vertical plane, and the second lock is movable between the engaged and disengaged positions in motion predominantly transverse to the central lengthwise-vertical plane. In another feature, the second lock is mounted on an hinge and pivots in a circumferential direction between the engaged and disengaged positions. In still another feature the second lock is mounted on an hinge, the hinge has an axis lying parallel to the lengthwise vertical plane, and the second lock pivots circumferentially between the engaged and disengaged positions. In another feature, the second lock is biased toward the engaged position. In still another feature, the second lock is biased toward the engaged position. In yet another feature the apparatus is one in which one of: (a) the second lock has a cam and the actuator has a mating cam follower; and (b) the second lock has a cam follower and the actuator has a mating cam. The cam and cam follower are co-operable, and are oriented to deflect the second lock away from the engaged position as the door moves from the open position to the closed position thereof.

In another aspect of the invention, there is a lock mechanism for a door actuating transmission of a railroad gondola car, the door actuating transmission including a reciprocating actuating cylinder mounted to a datum structure, the cylinder being movable forward and backward in an axial direction. The lock mechanism has a body having a first fitting, a second fitting and a third fitting. The first fitting is a mounting by which to connect the lock mechanism to the datum structure. The second fitting is one of (a) a cam for co-operation with a member of the door actuating transmission, that member being a cam follower; and (b) a cam follower for co-operation with a member of the door actuating transmission, that member being a cam. The third fitting includes an abutment for co-operation with a mating fitting of the door actuating transmission. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction.

In another feature, the lock mechanism there has a bias member oriented to urge the third fitting toward the first position thereof. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure. In another feature, the first degree of freedom of motion is an angular degree of freedom, and the predominantly cross-wise motion is predominantly circumferential motion about an axis of rotation. In a feature the first fitting is an hinge, the axis of rotation is an axis of rotation of the hinge, and the axis of rotation of the hinge is substantially parallel to the axial direction of the door actuating transmission. In still another further feature, the first fitting of the lock mechanism includes an hinge and a footing of the hinge for mounting to the datum structure. The axis of rotation is an axis of rotation of the hinge, and the footing has a substantially planar footprint. The axis of rotation of the hinge is angularly inclined relative to the substantially planar footprint. In yet another feature, the lock mechanism has all or any combination of the forgoing additional features.

In still another aspect of the invention there is a railroad hopper car for carrying particulate material. The hopper car there has a hopper and first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction. The hopper is suspended between the first and second end sections. The hopper has a discharge section through which to release lading, and first and second end slope sheets oriented toward the first and second end sections, the slope sheets being inclined in the longitudinal direction to feed the discharge section. The first end section includes a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to either side of the draft sill, and a shear plate mounted to the draft sill and to the main bolster. The shear plate extends lengthwise along the draft sill and cross-wise from side to side of the hopper car. The first end slope sheet of the hopper overhangs the shear plate of the first end section. The hopper car is free of primary structure directly above the shear plate of the first end section under the overhang of the first slope sheet of the hopper.

In another feature of that aspect of the invention, there is one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall. In another feature, the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. In a further feature, the bolster has first and second laterally outboard distal ends, and

the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet.

In still another feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. In another feature, one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall; the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. The bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. The hopper car has a machinery space bounded by (a) the first slope sheet; (b) the shear plate of the first end section; (c) the end post; and (d) the corner posts, and the machinery space is free of any other primary structure.

In yet another feature the hopper car has at least one longitudinally hinged discharge door, the discharge door being movable cross-wise between open and closed positions. A longitudinally acting pneumatic actuator is at least partially lodged in the machinery space directly above the draft sill. In still yet another feature a brake reservoir is also at least partially lodged in the machinery space. In a yet further feature the shear plate is mounted above and to the main bolster and defines an upper flange thereof. The main bolster has a lower flange downwardly spaced from the upper flange, the lower flange terminating at respective distal end portions at either side of the car. The car includes a side sill running along the car between the first and second end sections. The side sill has an upper flange, the upper flange of the side sill being substantially co-planar and connected to the shear plate. The side sill has a lower flange, the lower flange of the side sill being substantially co-planar with a respective one of the distal end portions of the lower flange of the main bolster. In another further feature, the shear plate defines an upper flange of the draft sill whereby the draft sill upper flange, the shear plate and the side sill upper flange are all substantially co-planar. In another feature the machinery space is free of elephant ears.

In a further aspect of the invention there is a railroad freight car having a freight car body for carrying lading, the body being mounted on railroad car trucks for rolling motion in a longitudinal direction along railroad tracks. The car body includes a draft sill having a draft gear pocket for accommodating draft gear, and a shear plate overlying the draft sill and functioning as an upper flange of the draft sill. The draft sill has an inboard end oriented toward a truck center of one of the trucks, and an outboard end terminating at a striker. The draft sill has an underside and an access opening formed in the underside to admit entry of draft gear into the draft gear pocket from below. The car has a draft gear carrier plate. The carrier plate is mounted to the underside of the draft sill beneath the draft gear pocket. The carrier plate is removable to permit installation of the draft gear into the draft gear pocket. The car body has one of (a) an aperture formed in the shear plate over an inboard end region of the draft sill, the aperture permitting a portion of the draft gear to protrude upwardly therethrough during installation in the draft gear pocket; and (b) a coupler carrier seat defined in the draft sill longitudinally inboard of the striker, and a coupler carrier co-operable therewith, the coupler carrier being removable to permit installation of draft gear in the draft pocket, and, when the coupler carrier is installed, the coupler carrier providing a support for a coupler shank when the coupler shank is connected to the draft gear within the draft sill.

In another feature of that aspect of the invention the freight car has both (a) and (b). In another feature, there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In still another feature, the draft sill has a pair of vertically oriented, longitudinally running spaced apart side webs. The webs have a greater depth of section adjacent to the striker. The webs have respective first and second apertures formed therein. The first and second apertures define the draft gear retainer seat, and the retainer is a sideways slidable shaft that is movable to extend across the draft sill between the first and second apertures in the draft sill side webs. In a further feature there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In another further feature the draft sill has a centerplate centered on the truck center, rear draft stops are welded within the draft sill, and at least a portion of each of the rear draft stops extends longitudinally inboard of the truck center. In still another further feature, the car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of less than 50 inches; and (b) the freight car has a truck center to coupler pulling face length of less than 65 inches when the draft gear is fully extended in draft. In another feature, the railroad freight car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of about 38 inches (+/−2"); and (b) the freight car has a truck center to coupler pulling face length of about 53 inches (+/−2") when the draft gear is fully extended in draft.

These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations.

BRIEF DESCRIPTION OF THE FIGURES

The description is accompanied by a set of illustrative Figures in which:

FIG. **1** is a general arrangement, isometric view of a railroad freight car according to an aspect of the invention with all ancillary systems removed to leave only primary structure visible;

FIG. **2***a* is an isometric view of a sidewall of the gondola car of FIG. **1**;

FIG. **2***b* shows a side view of the sidewall of FIG. **2***a;*

FIG. **2***c* shows an end view of the sidewall of FIG. **2***a;*

FIG. **3***a* shows a perspective view of the end structure of the railroad freight car of FIG. **1**;

FIG. **3***b* is a side view of the structure of FIG. **3***a;*

FIG. **3***c* is a detail of the end structure of FIG. **3***b*, with the near side web of the draft sill removed to show the draft stop, center plate, and coupler relationship.

FIG. **4***a* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully open position;

FIG. **4***b* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in an intermediate position;

FIG. **4***c* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully closed position;

FIG. **5***a* is a side view of the door opening mechanism of FIG. **4***a;*

FIG. **5***b* is a side view of the door opening mechanism of FIG. **4***b;*

FIG. **5***c* is a side view of the door opening mechanism of FIG. **4***c;*

FIG. **6***a* is an end view of the door opening mechanism of FIG. **4***a;*

FIG. **6***b* is an end view of the door opening mechanism of FIG. **4***b*; and

FIG. **6***c* is an end view of the door opening mechanism of FIG. **4***c;*

FIG. **7***a* is a perspective view of a secondary lock mechanism for the door opening mechanism of FIG. **4***a;*

FIG. **7***b* is a plan view of the mechanism of FIG. **7***a;*

FIG. **7***c* is a perspective view of the mechanism of FIG. **7***a* when the door are open

FIG. **7***d* is a view similar to FIG. **7***c*, of the mechanism of FIG. **7***a* in a deflected condition; and

FIG. **7***e* is a perspective view of the mechanism of FIG. **7***a* in a locked position;

DETAILED DESCRIPTION

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings may be taken as being to scale unless noted otherwise.

The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the rail road industry in North America. Following from decision of the CAFC in *Phillips* v. *AWH Corp.*, the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record in accordance with In re Lee, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years experience in the industry in North America or in other former territories of the British Empire and Commonwealth.

In terms of general orientation and directional nomenclature, for rail road cars described herein the longitudinal direction is defined as being coincident with the rolling direction of the rail road car, or rail road car unit, when located on tangent (that is, straight) track. In the case of a rail road car having a center sill, be it a stub sill or a straight-through center sill, the longitudinal direction is parallel to the center sill, and parallel to the top chords. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail, TOR, as a datum. In the context of the car as a whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, or of the centerline of a centerplate at a truck center. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit. Pitching motion is angular motion of a railcar unit about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the rail road car described herein may tend to have both longitudinal and transverse axes of symmetry, a description of one half of the car may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. In this description, the abbreviation kpsi stands for thousand of pounds per square inch. To the extent that this specification or the accompanying illustrations may refer to standards of the Association of American Railroads (AAR), such as to AAR plate sizes, those references are to be understood as at the earliest date of priority to which this application is entitled.

Bottom dumping hopper cars, of which ore cars and coal cars may be examples, may tend to have either longitudinal doors or transverse doors. Longitudinal doors are oriented such that the doors operate on hinges or axes of rotation that are parallel to the direction of travel of the railroad car generally. U.S. Pat. No. 4,250,814 of Stark et al., issued Feb. 17, 1981 and U.S. Pat. No. 3,800,711 of Tuttle, issued Apr. 2, 1974 show cars with longitudinal doors. By contrast, transverse doors are ones in which the axes of rotation of the hinges or other pivots tend to be predominantly cross-wise to the direction of travel, most often perpendicular to it. An example of a transverse door car shown in U.S. Pat. No. 4,843,974 of Ritter et al, issued Jul. 4, 1989.

FIG. **1** shows an isometric view of an example of a rail road freight car **20** that is intended to be representative of a range of rail road cars in which one or more of the various aspects of the present invention may be incorporated. While car **20** may be suitable for a variety of general purpose uses, it may be taken as being symbolic of, and in some ways a generic example of, a flow through car, in which lading is introduced by gravity flow from above, and removed by gravity discharge through gated or valved outlets below. Flow through, or center flow cars may include open topped hopper cars, grain cars, plastic pellet cars, potash cars, ore cars, coal gondolas, and so on. In one embodiment car **20** may be a hopper car such as may be used for the carriage of bulk commodities in the form of a granular particulate, be it in the nature of relatively coarse gravel or fine aggregate in the nature of fine gravel or sand or various ores, ore concentrate or coal. The principle, or primary, structure of car **20** may be symmetrical about both its longitudinal and transverse, or lateral, centerline axes. Consequently, it will be understood that the car has first and second, left and right hand side beams, bolsters and so on.

By way of a general overview, car **20** may have a car body **22** that is carried on trucks **24** for rolling operation along railroad tracks. Car **20** may be a single unit car, or it may be a multi-unit car having two or more car body units, where the multiple car body units may be substantially permanently connected at an articulated connector, or by draw bars, as opposed to by ordinarily releasable AAR couplers. Car body **22**, and the various structural members and fittings described herein may be understood to be typically of metal construction, whether welded or Huck™ bolted, or riveted together, the metal members being most typically steel, stainless steel, or aluminum, as may be appropriate. Some car builders have also used reinforced plastic composites for car elements, and those materials could also be employed where suitable. The default construction may be taken as being steel, of which the majority may be mild steel having, typically, a 50 kpsi yield. Car body **22** may have a lading containment vessel or shell **26** such as may include an upstanding wall structure **28** which

may have a pair of opposed first and second end walls **30**, **32**, that extend cross-wise, and a pair of first and second side walls **34**, **36** that extend lengthwise, the end walls **30**, **32** and side walls **34**, **36** co-operating to define a generally rectangular form of peripheral wall structure **28**. Wall structure **28** may include top chords **38** running along the top of the walls, and side sills **40** running fore-and-aft along lower portions of the side sheets or side sheet assemblies **42** of side walls **34**, **36**. In some instances, such as that of the illustration of FIG. **1***a*, car **20** may have stub center sills **44** at either end, in which case side walls **34**, **36** may act as deep beams, and may carry vertical loads to main bolsters **90** that extend laterally from the centerplates. In the case of a single, stand alone car unit, draft gear and releasable couplers may be mounted at either end of the stub center sill. In a center flow, or flow through car, the upper portion of the car may typically include means by which to admit lading under a gravity drop system. Such an intake **46**, or entryway may be a large rectangular opening such as that bounded by top chords **38**.

Car body **22** may include end sheets **48** and side sheets **50**. Car **20** of FIG. **1** et seq., is illustrated as a car having a single hopper **52**, a single hopper discharge section **54**, and an outflow or discharge governor in the nature of a discharge door assembly **56**. However, car **20** could, alternatively, be a multiple hopper car. In a multiple hopper car, the car may have laterally extending members or reinforcements, which may be cross-bearers, or cross-bearers with shrouds, or merely shrouds, particularly where the car is a multiple hopper car. These cross-members may run fully across the car from side sill to side sill, and may intersect the center sill, or the center sill shroud as may be. The car may also include upper wall bracing, in the nature of diagonal struts which extend diagonally upwardly and outwardly from the apices of the respective cross-members at the centerline of the car to upper regions of the side walls near or at the top chords; and lateral ties or struts that run across the car from sidewall to side wall to meet the upper ends of the diagonal struts at their wall brackets. Those brackets may be aligned with, and mated through the wall to, the vertical exterior posts that run from the side sill to the top chord and reinforce the walls.

End sheets **48** may be substantially planar slope sheets or slope sheet assemblies that are inclined downwardly in the longitudinally inboard direction to feed the discharge section. Not atypically, each pair of fore- and aft opposed slope sheets may be inclined at equal and opposite angles, and the angles of those sheets may be selected to be somewhat steeper than the free slope angle, or natural talus slope angle of the lading for which the car is designed, such that, when the gates are opened, the lading may tend to flow out, rather than sit at rest.

The primary structure of body **22** of car **20** includes lading containment vessel **26** which is in the nature of hopper **52**. Hopper **52** has an upper portion **58** with substantially vertical wall panels, and a lower stationary portion defined by a set of converging sloped walls, namely the side and end slope sheet assemblies **48** and **50**. At the lower margin of the sloped walls there is the outflow governor, namely door assembly **56**, which, in this instance, may have the form of a pair of first and second, or left and right hand doors **62**, **64**. This containment structure seats on, and is carried by, a pair of first and second end structures, **66**, **68**, at either end of the car. End structures **66**, **68** are in turn carried by trucks **24**. A door operating apparatus or mechanism, or drive train, or transmission, however it may be termed, and identified generally as **70**, is provided to move doors **62**, **64** between open and closed positions.

Considering this structure in greater detail, trucks **24** are most immediately surmounted by center plates **72** of longitudinally extending stub sills **44**. Stub sills **44** in turn carry laterally extending main bolster of main bolster **90**. Arms **74** extended perpendicularly away from the centerplate **72**, i.e., they are centered on the truck center, CL-Truck. Side sills **40** run lengthwise along the car between, and tie together, the most laterally outboard extremities of main bolster. A shear plate **76** is mounted in an x-y horizontal plane defining the top cover plate of stub sill **44**. Shear plate **76** extends laterally from side sill to side sill, and longitudinally from the fore-and-aft end slope sheet **48** to the laterally extending end sill **78** of the car, which, in this instance may be an upturned flange formed on the longitudinally outboard margin of shear plate **76**. In car **20**, the primary structure includes an end post **80** and a pair of side or corner posts **82**, **84**.

End post **80** is rooted in shear plate **76** in line with center sill **44**, and may have lateral webs or gussets aligned with the webs of stub sill **44** to provide vertical web continuity across shear plate **76**. End post **80** then extends fully between shear plate **76** and top chord **86** of end wall **30** or **32**, as may be. Corner posts **82** and **84** are rooted to, and stand upwardly from, the junction of the laterally outboard ends of left and right hand main bolster and side sills **40**. Posts **82** and **84** extend upwardly from this junction to mate with various elements of the end and side walls, as may be described below.

As described in additional detail below, car **20** has an abnormally short distance from the striker **88** to the truck center, i.e., the CL of centerplate **72**. Striker **88** is the vertical planar surrounding face plate at the outboard end of the stub sill **44**. In the terminology of the industry, the portion of the center sill **44** (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center CL-Truck may also be referred to as the draft sill. In car **20**, the short draft sill length, identified as L_{88}, leaves an anomalously small space in which to install other systems, such as the brake reservoir and the door operating pneumatic cylinder. Car **20** has an end of car machinery space, indicated generally as **75**, that is bounded by shear plate **76** on the bottom, the sloped end wall assembly **30** or **32** of the car on the top, main vertical central end post **80**, and main side posts **82**, **84** at the ends of main bolster **90**. This space may be referred to as having the shape, generally, of a triangular prism and is substantially unobstructed by the primary structure of the car. For the purposes of this description, primary structure is defined as the underframe, including side sills and center sill (i.e., including the draft sill), the side walls, the slope sheets and top chords, the hopper construction including the stationary parts of the discharge section, as well as any cross-bearers, cross-ties, bolsters, shear plates and so on. Primary structure excludes secondary or ancillary structure or systems such as ladders, cat-walks and other safety appliances, brakes, brake rods and brake fittings, air hoses, reservoirs and pneumatic fittings, movable door members, door operating linkages, and so on.

In existing cars, this space, **75**, is often occupied or otherwise obstructed by other primary structure, such as so-called "elephant ears". In this context, "elephant ears" are large, substantially triangular planar plates, sometimes provided with central lightening holes, that have one edge fixed along the junction of the center sill webs and the center sill cover plate, and another edge welded to the end slope sheet. The third edge is typically a free edge. Often these plates lie in a plane that is oriented at an angle to the vertical—i.e., it leans laterally outboard. Car **20** avoids the use of these "elephant ears" and so provides the large unobstructed space shown in FIG. **1***b*.

FIGS. **1** and **2***a*, **2***b* and **2***c*, all show the sidewall of the car, indicated generally as **34** or **36**. Sidewall **34** and **36** function as short beams of low (e.g., less than 4:1, possibly less than 3:1) length-to-depth ratio. Sidewall **34** or **36** can be seen to have a bottom flange or chord member, namely side sill **40**, a top flange or chord member, namely top chord **38**, which may have the form of a square or rectangular hollow structural steel tube; and an intermediate shear force transfer web, namely side sheet assembly **42**. Side sheet assembly **42** may include an upper sheet portion or member **92** that is welded to the outside face of top chord **38** at a lap joint, and that extends downwardly therefrom; and a lower sheet portion or member **94**. Member **94** may have the form of a Z-section, having a first portion, namely an upper flange or leg or margin **96** that extends in a substantially vertical plane and has an uppermost margin that overlaps the lowermost edge or margin of member **92**; a second or intermediate portion **98** that runs in an inclined plane sloping inwardly and downwardly on the slope of the hopper side sheets generally, and a third or bottom portion, namely bottom flange, or leg, or margin **100** that extends in a substantially vertical plane downwardly. Sidewall **34** or **36** also includes a central post, or web stiffener, **102** that has a lowermost first portion **104** an intermediate second portion **106**, and an uppermost third portion **108**.

Side sill **40** includes a channel **110** that is welded toes-inward against the lowermost marginal portion of lower leg **100** to form a closed section. The first or lowermost portion **104** of web stiffener **102** has the form of a quadrilateral gusset having a first edge welded to the upper leg of channel **110**, a second edge welded to the vertical margin **100**, a third edge welded to the sloping portion **98**, and the fourth, laterally outboard, edge being free. As may be noted, portion **104** stands outboard of the sidewall sheet.

Portion **108** is a rectangular web stiffener that is welded to, and extends downwardly from, the underside of top chord **38** along the inside face of vertical web portion **92**. Intermediate portion **106** is a web, or plate, or gusset, that is also a quadrilateral, having a first edge that overlaps, and is welded to, the lower margin of portion **108**. A second edge is welded to the lower region of vertical web portion **92**, and to the upper flange or leg **96**. A third edge is welded along the sloped portion **98** of member **94**. The fourth edge is free, and faces inwardly into the lading containment space of the hopper. Portions **104** and **106** are co-planar, or substantially co-planar, such that stiffener **102** has web continuity through member **94**. The upper margin of the side slope sheet **50** of the hopper discharge section is welded to the lower margin of the inclined or sloped portion **98**, such that the structure presents a continuous sloped surface for containing, and then slidingly discharging, particulate lading. Expressed differently, the web of the sidewall traverses the sidewall stiffener, commencing on its inboard margin at side sill **40**, traverses the web mid-way up the post, and ends along its outboard margin at top chord **38**. In this arrangement, the vertical stiffener, **102**, acts as the web of a T-section, and the local region of the wall section to which it is joined functions as the flange of that T-section.

In this example, the locus of intersection of the side slope sheet plane P_{94} with the plane of the side wall sheet P_{92}, lies above the level of side sill **40** by a substantial distance, indicated as L_{94}. This distance may lie in the range of ¼ to ⅔ of the distance L_{SW} from side sill **40** to top chord **38**, and, in the particular may be about ⅓ of that distance. Further, although the post has stiffening member web continuity in a vertical plane, the wall sheet traverses the stiffening web intermediate the top chord and the side sill, and does so obliquely on the slope of plane P_{94}.

The upper leg of channel **110** forms the upper flange of side sill **40**, and the lower leg of channel **110** forms the lower flange of side sill **40**. Shear plate **76** forms the top flange of main bolster **90**. Main bolster **90** also has a lower or bottom flange **91**. In car **20** the upper leg of channel **110** is co-planar or substantially co-planar with, and is connected in flange continuity with, shear plate **76**. Similarly, the lower leg of channel **110** is co-planar or substantially co-planar with, and connected in flange continuity with, bottom flange **91** of main bolster **90**.

Continuing with the sidewall assembly, the main sheet, namely upper sheet portion **92**, ends at the corners, and there are respective first and second end upper web stiffener portions and inwardly stepped plate members **112**, which may be termed "ears". The top edge of each ear is welded to the inside face of top chord **38** in a lap joint. The longitudinally outboard end edge forms a plane to which the vertical end sheet of the end slope sheet wall abuts and is welded. The bottom edge follows the slope of, and is welded to, end slope sheet **48**. The forward, transversely outwardly bent edge is welded to the upper end portion of side sheet assembly **42**. The lower region of the main sidewall sheet also includes lightening apertures **114**, in the space between the corner posts and the slope of the end slope sheets. Finally, the lower portion of region **100** of the main sidewall sheet has longitudinal extensions **116** that are welded to the side edges of the shear panel, namely shear plate **76**, outboard of main bolster **90**, thereby forming a portion of the peripheral flange of the shear plate.

End walls **30**, **32** each include upper and lower sloped surface members **122** and **124**, which could be made as a single piece, or as two pieces butt-welded together, as here. Upper member **122** has notches **126** formed therein to accommodate corresponding corner posts **82**, **84** as may be, with local reinforcement doublers **128** at the junction. Lower portion **124** tapers in width to match the narrowing width between the sloped side sheets with which it mates. At the upper end of end wall **30** the end wall assembly includes a laterally extending first formed member **130** that has a first, vertical leg **132** that laps the inside face of the top chord **86**, and a bent flange **136** that extends initially horizontally, with a distal lip bent upward to mate perpendicularly with the upper margin **138** of the end slope sheet **48**. The distal tip of end slope sheet **48** is fillet welded to vertical leg **132**. This results in a substantially triangular closed section defining a laterally extending end slope sheet reinforcement beam **140**. The ends of this beam abut, are welded to, and are capped by elephant ears **112**. Vertical leg **132** also lies against, and is welded to, end post **80**.

A formed angle **142** is mounted toes-in at an intermediate height on sloped end wall **48**, forming thereby another hollow section laterally extending end sheet reinforcement or beam **148**. Vertical leg **144** of angle **142** is substantially aligned with the central web of the corner post (be it **82** or **84**) and therefore also with the central web of the main bolster. Another formed angle **150** is welded toes-in to the back of sloped end wall **30** at the level of shear plate, thereby forming yet another slope-sheet reinforcement in the form of a laterally extending beam.

The corner posts **82** and **84** each have a lower corner post flange plate **160** (that includes a lifting lug aperture) that has a bottom tab welded to the outside, or back, of the end of side sill **40** in line with the main bolster, then an angled portion following the angle of the outside edge of the vertically extending side wall reinforcements, **161**, to an upper end at the juncture of the side slope sheet with the side wall vertical leg of the lower side wall sheet. Each end post has two internal reinforcements **154**. Each corner post also includes an intermediate member, or web, or gusset, or plate **162**, which is

considerably wider than intermediate gusset **106**, and a substantially triangular inside edge web stiffener **164**. Plate **162** is a quadrilateral. A first edge of plate **162** runs along the upward and outward slope of wall extension **166**. A second edge runs vertically against the upper leg of wall extension **166**. A third upper edge adjacent runs horizontally along lateral reinforcement beam **148**. The fourth edge runs vertically downward to and along edge stiffener **164**. As such, a vertical post is established.

Considering FIGS. **3***a*, **3***b* and **3***c*, center sill **44** includes a bottom flange or bottom cover plate **165**, and a pair of spaced apart webs **168**. The central region of shear plate **76** forms the top flange, or top cover plate of the center sill. At its inboard end, the center sill terminates centrally under the bottom lateral reinforcement of the end slope sheet **48**. A draft pocket **175** is defined between webs **168**, shear plate **76** and bottom cover plate **165** longitudinally inboard of the striker plate.

Center plate **72** is mounted at truck center CL-Truck, in line with main bolster **90** and the corner posts **82**, **84**. Rear draft stops **172** are welded within the center sill above center plate **72**. As seen in FIG. **3***c*, the inboard end of rear draft stop **172** extends longitudinally inboard of the truck center. While this is known to have been used in at least one single piece, integrally cast draft sill, the inventor is unaware of such a construction in an all-welded fabrication draft sill assembly. The removable draft sill access cover plate, or draft gear carrier plate **174**, which is bolted to the draft sill (i.e., the stub sill) bottom flange margins, is mounted immediately longitudinally outboard of center plate **72**. Front draft stops **176** are, in turn, mounted longitudinally outboard of carrier plate **174**. In this embodiment there is also a removable member, such as a top leeway or access plate **178**, mounted to shear plate **76**. Plate **178** is removed when draft gear **180** is removed or installed. On installation, draft gear **180**, to which yoke **188** is already mounted, is fed into draft pocket **175** from below, on an angle, whereby the rear corner protrudes upwardly through the opening that is otherwise covered by plate **178**. The front end of draft gear **180** is rotated into place, and the rear end is rotated downward. As this occurs, yoke **188** is also raised into place. Plates **178** and **174** are then reinstalled. The shank **182** of the coupler, **184** is inserted, and the coupler key **186** is fed through the slot in front draft stops **176** to link coupler **184**, and yoke **188** in the customary manner. It may be noted that coupler **184** combines an AAR Type E shank with and AAR Type F knuckle with a bottom shelf. Draft gear **180** itself has abnormally short travel, namely about 2½ inches deflection before going solid, as compared to a "normal" deflection of over 3" before going solid.

Draft sill webs **164** have, at their longitudinally outboard end an end portion **190** of increased depth of section with a downwardly protruding bulge or horn, such as might be termed a "chin". End portion **190** has an aperture or slot **192** formed therein to permit lateral sliding insertion of a coupler support, carrier or bar **194** immediately behind striker plate **88**. Removal of bar **194** permits yoke **188** to be swung into place during installation of draft gear **180**. When coupler **184** is installed, the shank may rest on bar **194**. Bar **194** is held in place by bolts that secure it relative to webs **164**. Overall, a coupler installation of very short length is achieved. In this example, L_{88} may be in the range of less than 50 inches, and in one embodiment may be about 38"+/−2", from the truck center to the outboard face of striker plate **88**. An alternative expression of the relative compactness of the draft gear is that the length from the truck center to the pulling face of the coupler, when the draft gear is extended in tension, is in the range of less than 65 inches, and in one embodiment is in the range of 53"+/−2".

Car **20** may also include a door opening mechanism **200**. There are left and right hand, or first and second, doors **62**, **64**. Each door has a proximal, hinged edge **206**, and a distal free edge **208**. The hinges are carried on hinge fittings welded to mounting brackets depending from the slope sheets and side sills. The hinges run parallel to the longitudinal or lengthwise axis of the car, generally such that doors **62**, **64** are longitudinal doors. Each door has the form of a hollow section beam, having a proximal beam **210** along the hinge side, a distal beam **212** along the free edge, internal cross-braces, not shown, and front and back skins or sheets or plates **214**, **216**. The hinges are indicated as **220**, the end closure plates as **222**, **224**. The doors have door seal members **226**, **228** that mutually engage when the doors are moved to a closed position. Seal members **226**, **228** are sprung, such that when they are closed they deflect somewhat and in so doing take on a spring pre-load against each other. The door mechanism includes a pair of first and second, matched left and right hand pivot arms **230**, **232**; a corresponding pair of first and second drag links **234**, **236**; a shared yoke **238**, and a pair of slave links **240**, **242** that each pick up on a knuckle fitting **244**, **246** of each of respective doors **62**, **64**. The whole assembly has left and right hand symmetry.

Inasmuch as, when tripped, doors **62**, **64** open under the influence of gravity, particularly when assisted by the weight of the lading being discharged, one may consider the motion that occurs as the doors are closed in the sequence of views **4***a*, **4***b*, and **4***c*; **5***a*, **5***b*, and **5***c*; and **6***a*, **6***b* and **6***c*. Knuckles **244** and **246** are constrained by geometry to move in circular arcs of fixed radii in planes perpendicular to the respective axes of rotation of doors **62** and **64**, those axes being the hinge axes of their respective hinges **220**, which each lie in a plane parallel to the x-z plane of the car centerline. The plane of rotation of knuckles **244**, **246** will then tend to be perpendicular to the central x-z plane. Slave links **240** and **242** are each of fixed length; each has an end pivotally connected at a two rotational degree of freedom knuckle, be it **244** or **246**, as may be; each of slave links **240** and **242** has another end pivotally connected at a second pivot connection at yoke **238**; and slave links **240** and **242** do not transmit a bending moment, and so therefore pull in pure tension. The upper, or near (i.e., proximal), ends of drag links **234**, **236** are connected to the distal ends of pivot arms **230**, **232** at pivot connections **248**, **250**, which may, if desired, share a common axis of rotation or pivot pin.

Yoke **238** is constrained by symmetry to pull in an x-z plane, which in the embodiment illustrated is the vertical plane of the centerline of the car. As such, movement of yoke **238** away from the plane of motion of knuckles **244** and **246** will necessarily draw knuckle fittings **244** and **246** closer together, and toward the vertical centerline plane of the car, eventually causing resilient door seals **226**, **228** mutually to engage, thus closing the opening. This motion can be achieved by pulling on drag links **234**, **236**. Each pivot connection of slave links **240**, **242** has a single angular degree of freedom. Similarly yoke **238** has an angular degree of freedom about the axis of rotation of the axle, or trunnions, by which it is pivotally mounted to the drag link, or drag links **234**, **236**. This gives the drag link connection two angular degrees of freedom in total. As the drag links are withdrawn, the slave links pull in tension, finding the natural hypotenuse between the plane of the arc of motion of knuckle fittings **244**, **246** and the plane of motion of drag links **234**, **236**. Since this mechanism operates in tension, pivot connections **248**, **250** and knuckle fittings **244**, **246** are co-planar, with drag links

234, 236, yoke 238, slave links 240 and 242, and their associated pivot connections also lying in that same plane as well. (See FIGS. 5*a*, 5*b*, 5*c*).

Driving force for this system is provided by an actuator, identified as 260. Actuator 260 may be a pneumatic actuator, which may be charged by the pneumatic system of the train generally, as supplied through the pressurized air connection of the train line. Actuator 260 may include its own reservoir and check valve. Actuator 260 is connected to move a first member, in the nature of a primary driven pivot arm or lever, 262, which is in this instance actually a pair of matched lever arm members, which in turn is pivotally connected to, and drives, a second member in the nature of, a push rod, or, given the symmetrical nature of the assembly, a pair of left and right hand push rods 264 and 266. One or both of push rods 264, 266 may have a secondary member, such as may be an extending arm, or detent, or stop, or abutment, identified as an over-center travel limiter or governor, 268. The far ends of push rods 264, 266 may be connected to either pivot (or 232, as may be), or to drag link 234 (or 236, as may be). It may be convenient to connect the far end of push rods 264, 266 at the same pivot connection, or connections 248, 250.

Lever 262 has a first end pivotally mounted to primary structure of car 20 at footings, identified as mounting fixtures, fittings or brackets 270. The drive rod of actuator 260 picks up on lever 262 at an intermediate location, such that lever 262 provides magnification of displacement. Similarly, pivot arms 230, 232 have a first or base end pivotally connected to primary structure at mounting fixtures, fittings, or brackets 272. Actuator 260 is located on the centerline (i.e., in the central x-z plane) of car 20, between and in substance below pivot arms 230, 232. "Below" in this context may be thought of as radially more proximate to the pivot axis P_{270} of brackets 270 than is the pivot axis of connections 248, 250, as well as in the context of being lower than as in closer to Top of Rail. In the past the lever fitting has more commonly been mounted to the slope sheet such that the output pin is lower than the pneumatic cylinder. Turning this arrangement upside down, in effect, and fitting the cylinder may then permit a more compact installation than otherwise. Similarly, the pivot axis, P_{230}, of driven arms 230, 232 is below the output knuckle, i.e., at P_{250}, and is below the actuator cylinder as shown in FIG. 5*b* in which P_{250} lies below the center line CL_{260} or actuator 260. This may be taken in the sense of being further from the plane of the end slope sheets, identified as P_{48}. Expressed differently, actuator 260 lies between the base or datum pivot point P_{250} of driven arms 230, 232 and the plane P_{48} of end slope sheet 48.

As may be noted, the line of action of drag links 234, 236 has a predominant component that is substantially parallel to plane P_{48}. Expressed differently, at some point during mid-stroke, the line of action will be at least instantaneously parallel to plane P_{48}. Finally, it may be noted that rather than placing actuator 260 on shear plate 76, and orienting actuator 260 such that its longitudinal axis (i.e., the working axis or axis of reciprocation of the actuator), that actuator is itself raised upwardly from the shear plate and oriented to work along a line of action that is tilted downward and longitudinally inboard, the angle of tilt being identified as α_{260}. This angle of inclination lies in the range from horizontal to the angle of inclination of end slope sheet 48, identified in FIG. 5*c* as α_{48}. Placing the mounts and pivot points under the apparatus, raising the actuator cylinder, orienting it on an incline, and making the line of action or the zone swept by the draglinks in the progressions of FIGS. 4*a*, 4*b* and 4*c* (or 5*a*, 5*b* and 5*c*) tend to correspond to a displacement substantially or predominantly parallel to plane P_{48}, all aid in providing a more compact installation, in particular one that is longitudinally short as may suit the short distance from the truck center to the striker. It is also an installation that may tend to leave space for other car systems, such as the brake system.

This arrangement may be thought of in terms of a four bar, or multi-bar, linkage. The first bar of the linkage may be thought of as being the underframe, and structure rigidly mounted to the underframe. This is the datum, or frame of reference member of the linkage. The second member or linkage component is the first pivot arm, 230 (or 232) having a fixed main pivot point, and an output distal pivot point constrained to move on a fixed radius about main pivot point P_{230}. The fourth component or element of the linkage is the second pivot arm, namely 62 or 64, each of which is a second lever or pivot arm mounted to a pivot axis fixed with respect to the first or datum link, and having a distal connection, in this case also a pivot connection, constrained to move in an arc of constant radius about the base pivot axis. The third linkage is the drag link. Although the drag link is made of two portions that are held together at yoke 238, the geometric symmetry of the assembly constrains both the upper portion of the drag link, (i.e., drag link 234, 236) and the lower portions, (i.e., slave links 240, 242) to be co-planar during closing of the doors. In any case, the single input of the actuator cylinder acting through the over-center links against the first pivot arm (at the distal pivot connection) produces a unique output geometry such that position of the elements is determinate as if it were a four bar linkage.

When the door opening apparatus is retracted to the position shown in FIGS. 4*c*, 5*c* and 6*c*, driven primary pivot arms and the over-center links are driven to a slightly over-center relationship such that the pivot connection between the primary pivot arms and the over center arms lies below a line drawn from the primary pivot axis and the over-center link output connection as axis P_{250}. In this condition tensile force on drag links 234 and 236 (as from weight placed on doors 62, 64, for example) will tend to urge the main driven pivot arms, namely lever 262, counter-clockwise as viewed in FIG. 4*c*. Motion in this direction is prevented by the over center stop, 268, thereby defining a first lock that prevents inadvertent opening of doors 62, 64 from moving to the open position when actuator 260 is dormant, i.e., inactive. This first lock is released by reversing actuator 260 to open the doors.

Car 20 has a secondary door mechanism, or secondary latching system, identified generally as 300. This secondary latch system, and, indeed, the door closure linkage apparatus of FIGS. 7*a*-7*e*, are slightly different from those shown in FIGS. 4*a*, 5*a*, and 6*a*. In latching system 300 there is a latch assembly 302, shown in FIGS. 7*a* and 7*b*. Assembly 302 includes a first member, or main member, or plate 304, which performs the function of a body or armature or spider that ties the other various physical elements of the assembly together. Along one edge plate 304 has physical motion constraint fittings, identified as hinge fittings 306, that limit plate 304 (and assembly 302 more generally) to a single degree of freedom, that single degree of freedom limiting plate 304 to motion of any point to motion in a plane perpendicular to the hinge axis, and in particular to pivotal motion in that plane about that axis. To the extent that the hinge axis is substantially or predominantly parallel to the axis of reciprocation of pneumatic actuator 260, that motion can be said to be sideways, or predominantly transverse of cross-wise to that direction of reciprocation.

Plate 304 has a portion or finger, or arm member 308 extending away from the hinge. In this case, arm member 308 extends arcuately away, and has a bent termination, or end, or lip, or tip, indicated at 310. Another member 312 in the form

of a block is mounted, e.g., welded, at the distal end of arm member **308**. Member **312** has the same general shape, a dog-leg bend, as tip **310**. Member **312** has a first, generally inwardly (i.e., away from the tip) facing surface **314** that defines an abutment **316**. Member **312** also has an oblique surface **318** that defines a wear or cam surface, which may be termed a reset cam, or return cam.

Another member **320**, which may have the form of a plate or block, is welded to the major portion of the body of plate **304** relatively close to the hinge axis. The axially foremost face of member **322** is relieved—i.e., it does not define a face in a plane perpendicular to the hinge axis—or to the axis of reciprocation of the pneumatic actuator clevis. This face may be arcuate or chamfered, and so defines a first or deflection cam **324**. That is, as installed, it lies in the path of actuator clevis **330**. When the leading corner of clevis **330** encounters cam **324**, plate **304** will tend to be urged to rotate, i.e., pivot, about its axis in the clockwise direction as viewed looking from actuator **260** toward hopper **52**. Assembly **302** also includes a motion resisting, or return biasing member in the form of a spring, identified as leaf spring **326** that is anchored at the proximal end to stationary structure of the secondary lock footing, or base, **328** which is welded to shear plate **76**. The footprint of base **328** against shear plate **76** is planar. The hinge axis is inclined relative to the plane as shown, the angle of inclination being substantially similar to, and possibly the same as, the mid-stroke angle of inclination of actuator **260** (which, itself, varies slightly during operation). The distal end of spring **326** bears against plate **304** distant from the hinge. Finally, assembly **302** includes reaction force transmission members **332**, **334** in the form of welded flat bars that bear against, i.e., abut, the longitudinally outboard face of mounting fitting **270** when the latch is in the engaged position.

In operation, as actuator **260** works, lost motion is taken up in slot **336** of the distal or forward end **338** of the reciprocating actuator ram. Eventually the end of slot **336** engages a pivot pin **340** of bell crank arm **342** and causes driven member **344** (analogous to driven member **262**), causing it to rotate counterclockwise as viewed in FIG. **7***a*. This forces push rods **346**, **348** (analogous to push rods **264**, **266**) to act against connections **248**, **250**, and hence to force drag links **234**, **236** along their retracting path. Since **262**, **264**, **230** and the car body form a four bar linkage, the output path of connections **248**, **250** is determinate and unique.

While this happens, clevis **338** keeps moving rearward to engage reset cam surface **318**, with the effect that assembly **302** is urged to rotate out of the way, against the resistance of spring **326** (FIG. **7***d*). Eventually the trailing portion of clevis **338** clears cam **324**, and soon thereafter the most longitudinally inboard edge of driven member **344** clears abutment **316**. Assembly **302** then moves under the influence of spring **326** into the locked position shown in FIG. **7***e*. In this locked position, any moment tending to pivot driven member **344** clockwise is reacted not by the hinge fittings, but rather by the reinforcements, namely members **332**, **334**. In this locked position driven member **344** and push rods **346**, **348** are drawn to, and locked in, their over center position.

When the doors are to be released, actuator **260** moves in the opposite direction. The lost motion of the length of slot **336** reverses, such that the end of clevis **338** bears against the release cam, namely cam surface **324**, which causes plate **304** to pivot away, and thus disengages abutment **316**, moving it out of the path of driven member **262** against which it would otherwise abut. The outboard end of slot **336** then engages pin **340**, releasing the over-center hold of driven member **344**, and permitting the doors to open under the influence of gravity.

The cams need not necessarily be on the plate, i.e., the latch body, but could be on the clevis, as shown at **350** in FIG. **4***c*. That is, it is to some extent arbitrary which part is identified as the cam, and which part is identified as the cam follower. The point is that the parts mutually engage such that the one intercepts the other during motion of the actuator cylinder to trip the door opening condition, with the result that the secondary latch is urged to deflect out of the way sideways. In the other direction, of course, the abutment relationship of items **262** and **316** prevents the doors from opening. The apparatus of FIG. **4***c* works in substantially the same way, and combines both arms of the bell crank driven member **344** into a single driven lever, namely lever **262**.

In summary, car **20** has a first lock, the over center lock, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. Car **20** also has a second lock, symbolized by latching system **300**, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator. Actuator **260** is positioned to reciprocate in the central lengthwise-vertical plane of car **20**. Latching system **300** is movable predominantly transverse to the central lengthwise-vertical plane as it pivots in a circumferential direction between the engaged and disengaged positions. The hinge axis lies parallel to the lengthwise vertical plane, and the second lock pivots circumferentially. The second lock is biased toward the engaged position. The lock mechanism can be thought of as having a first fitting, a second fitting and a third fitting. The first fitting is the mounting, **238** by which to connect the lock mechanism to the datum structure. The second fitting is one of a cam or a cam follower for co-operation with a member of the door actuating transmission. The third fitting is the abutment, i.e., **316**, that co-operates with a mating part of the door actuating transmission, in this case the side of lever **262**. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure, namely shear plate **76**. The first degree of freedom of motion is an angular degree of freedom, and is predominantly cross-wise circumferential motion. The axis of rotation is the hinge axis, which is substantially parallel to the axial direction of the door actuating transmission.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

We claim:

1. A rail road hopper car comprising:

a hopper carried between a pair of trucks, said hopper having first and second upstanding sidewalls running lengthwise therealong;

said hopper having a lower discharge and convergent slope sheets giving onto said discharge;

said rail road car having a side sill and a top chord;

said first upstanding sidewall extending from said side sill to said top chord;

said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;

said first upstanding sidewall having a first region, said first region being a lower region thereof;

said first upstanding sidewall having a second region, said second region being an upper region thereof;

said sidewall stiffener having a first portion, said first portion being a lower portion thereof, said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;

said first portion of said first upstanding sidewall stiffener being laterally outboard of said first region of said first upstanding sidewall;

said second portion of said sidewall stiffener being laterally inboard of said second region of said first upstanding sidewall;

said first sidewall having a continuous section between said first and second regions thereof; and

said sidewall stiffener having web continuity between said first and second portions thereof.

2. A rail road hopper car comprising:

a hopper carried between a first end section and a second end section;

said first and second end sections being carried by respective first and second trucks for rolling motion in a longitudinal direction along railroad tracks;

said hopper having first and second upstanding sidewalls running lengthwise therealong;

said hopper having a lower discharge and convergent slope sheets that slope downward toward said discharge;

said discharge having a door movable between a closed position and an open position to govern egress of lading from said hopper;

one of said convergent slope sheets being a first end slope sheet;

said first end slope sheet extending laterally between said first and second upstanding sidewalls;

said first end slope sheet having a first, lower, longitudinally inboard end proximate said discharge, and a second, upper, longitudinally outboard end distant from said discharge;

said first end section having a first draft sill and a main bolster extending cross-wise to said first draft sill, said first draft sill and said main bolster intersecting at a first truck center, said first truck being located centrally under said first truck center;

said draft sill having a striker longitudinally outboard of said first truck center;

said first end section having a shear plate mounted overtop of said first draft sill and said main bolster;

said shear plate having a longitudinally inboard margin adjacent to said longitudinally inboard end of said first end slope sheet;

said shear plate having a longitudinally outboard cross-wise running margin traversing said draft sill longitudinally outboard of said truck center;

said upper, longitudinally outboard end of said first end slope sheet being reinforced by a first cross-wise extending beam;

said lower, longitudinally inboard end of said first end slope sheet being reinforced by a second cross-wise extending beam;

said first end slope sheet overhanging said shear plate;

a door actuator mounted above said shear plate, said door actuator being at least partially overhung by said first end slope sheet;

said door actuator being connected to said door by a mechanical transmission;

said first end section being free of longitudinally oriented elephant ears extending between said draft sill and said first end slope sheet;

said hopper having respective first and second top chords running longitudinally therealong;

said car having respective first and second side sills running longitudinally between said first and second end sections;

said first upstanding sidewall having a predominantly upwardly running sidewall stiffener mounted thereto, said sidewall stiffener being located at a longitudinal station intermediate the trucks;

said first upstanding sidewall having a first region, said first region being a lower region thereof;

said first upstanding sidewall having a second region, said second region being an upper region thereof;

said first and second regions of said sidewall adjoining each other at a height intermediate said first side sill and said first top chord;

said second region of said sidewall extending downwardly or said first top chord;

said first region of said sidewall extending downwardly and laterally inboard from said second region of said sidewall;

said sidewall stiffener having a first portion, said first portion being a lower portion thereof,

said first portion being mounted to said first region of said first upstanding sidewall;

said sidewall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said first upstanding sidewall;

said first portion of said first upstanding sidewall stiffener being laterally outboard of said first region of said first upstanding sidewall;

said second portion of said sidewall stiffener being laterally inboard of said second region of said first upstanding sidewall;

said first sidewall having a continuous section between said first and second regions thereof; and

said sidewall stiffener having web continuity between said first and second portions thereof.

3. The rail road hopper car of claim 2 wherein said first and second portions of said sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

4. The rail road hopper car of claim 2 wherein said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet

transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and said stiffener having vertical web continuity through said transition portion.

5. The rail road hopper car of claim **4** wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said transition portion is located a distance above said first side sill that is in the range of ¼ to ⅔ L.

6. The rail road hopper car of claim **2** wherein:

said first upstanding sidewall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said sidewall stiffener from an inboard margin thereof to an outboard margin thereof;

said hopper includes first and second sloped side sheets; and

said first sloped side sheet meets said first sidewall at said transition portion.

7. The rail road hopper car of claim **6** wherein said first sidewall has an overall height from said first side sill to said first top chord, L, and said first sloped side sheet meets said transition portion at an height that is in the range of ¼ to ⅔ L above said first side sill.

8. The rail road hopper car of claim **2** wherein said hopper has a cross-wise extending outboard end top chord; and an end post extends from said draft sill to said end top chord, said end post being mounted above said draft sill between said truck center and said striker.

9. The rail road hopper car of claim **8** wherein:

said hopper has an end wall extending downward of said end top chord;

said upper, longitudinally outboard end of said first end slope sheet meets said downwardly extending end wall; and

said first cross-wise extending beam is located where said downwardly extending end wall meets said first end slope sheet; and

said first cross-wise extending beam is of hollow cross-section.

10. The rail road hopper car of claim **8** wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

11. The rail road hopper car of claim **10** wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.

12. The rail road hopper car of claim **2** wherein said main bolster has first and second ends; and first and second corner posts extend upwardly from said first and second ends respectively to mate with said sidewalls.

13. The rail road hopper car of claim **12** wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

14. The rail road hopper car of claim **2** wherein said shear plate has lateral margins; said lateral margins of said shear plate mate with said first and second side sills; and said sidewall stiffener is supported by a respective one of said side sills.

15. The rail road hopper car of claim **2** wherein said first and second portions of said sidewall stiffener are made of flat bar, are positioned in vertical-transverse planes, are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

* * * * *

EXHIBIT A2-2

US008132515B2

(12) **United States Patent**
Forbes et al.

(10) **Patent No.: US 8,132,515 B2**
(45) **Date of Patent: Mar. 13, 2012**

(54) **RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR**

(75) Inventors: **James W. Forbes**, Campbellville (CA); **Marcus Thiesen**, Hamilton (CA); **Dave Keats**, Brantford (CA)

(73) Assignee: **National Steel Car Limited** (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/816,660**

(22) Filed: **Jun. 16, 2010**

(65) **Prior Publication Data**

US 2010/0251922 A1 Oct. 7, 2010

Related U.S. Application Data

(62) Division of application No. 12/559,065, filed on Sep. 14, 2009.

(30) **Foreign Application Priority Data**

Sep. 14, 2009 (CA) 2678605

(51) **Int. Cl.**
B61D 17/00 (2006.01)

(52) **U.S. Cl.** **105/406.1**; 105/248; 105/240; 105/247; 105/250

(58) **Field of Classification Search** 105/406.1, 105/406.2, 396, 404, 411, 413, 416, 417, 105/418, 419, 250
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

673,103 A * 4/1901 Williamson et al. 105/248
(Continued)

FOREIGN PATENT DOCUMENTS

CA 1082524 A1 7/2009
(Continued)

OTHER PUBLICATIONS

5 Photographs of Quebec Iron and Titanium (QIT) ore hopper car No. 556, dated Aug. 15, 2007.

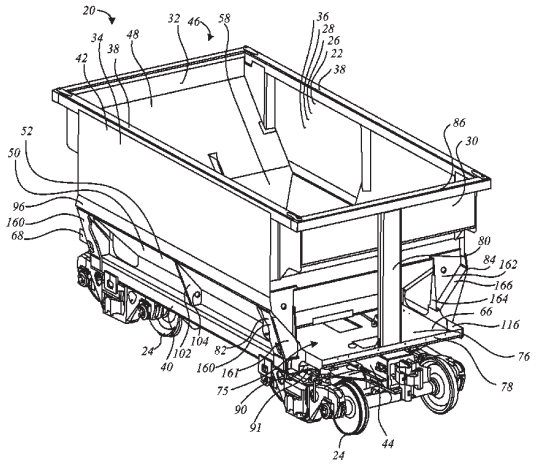
(Continued)

Primary Examiner — Joe Morano, IV
Assistant Examiner — Jason C Smith
(74) *Attorney, Agent, or Firm* — Hahn Loeser & Parks LLP; Michael H. Minns

(57) **ABSTRACT**

A railroad gondola car has a hopper carried between two trucks. The hopper has convergent end and side slope sheets that feed a bottom discharge. The bottom discharge has a pair of longitudinal doors. The door closing mechanism is a mechanical transmission that includes a set of linkages running from the door to a reciprocating pneumatic cylinder. The linkages run generally parallel to the slope sheet. The car has a very short draft installation that includes a removable coupler carrier bar, and the main shear plate has a removable draft gear installation panel. There is a machinery space above the end section shear plate. It is overhung by the slope sheet that is substantially unobstructed by any other primary structure. The pneumatic cylinder is mounted on an angle in this unobstructed machinery space, oriented longitudinally over the draft sill beneath the main drag link of the mechanical transmission, and above the main pivot of the driving input lever of the transmission. The main lever is bifurcated, and straddles the pneumatic cylinder. The mechanism includes a primary lock in the form of an over center lever arrangement, and a compact secondary lock that acts sideways rather than lengthwise. The sidewalls of the car include vertical stiffeners and side sheets. The lower portion of the side sheets lies laterally inboard of the stiffener web, while the upper portion lies laterally outboard of the stiffener web. The side slope sheet of the hopper meets the sidewall at the transition of the sidewall sheet from the inside-the-post to the outside-the-post condition.

44 Claims, 18 Drawing Sheets



U.S. PATENT DOCUMENTS

763,186	A		6/1904	Johnson	
1,421,439	A		7/1922	Finckh	
3,173,381	A		3/1965	Charles et al.	
3,187,684	A		6/1965	Ortner	
3,405,655	A	*	10/1968	Dorey	105/250
3,408,956	A		11/1968	Rebenok et al.	
3,483,830	A		12/1969	McGrath	
3,577,932	A		5/1971	Pulcrano et al.	
3,596,609	A		8/1971	Ortner	
3,611,947	A		10/1971	Nagy	
3,654,873	A		4/1972	Floehr	
3,710,730	A	*	1/1973	Austgen et al.	105/250
3,717,109	A		2/1973	Miller	
3,717,110	A		2/1973	Miller	
3,800,711	A		4/1974	Tuttle	
3,807,316	A		4/1974	Miller	
3,815,514	A		6/1974	Heap	
3,818,842	A		6/1974	Heap	
3,863,986	A		2/1975	Mentessi	
3,872,796	A		3/1975	Alder et al.	
3,878,794	A		4/1975	Adler	
3,931,768	A		1/1976	Price et al.	
3,949,681	A		4/1976	Miller	
3,994,238	A		11/1976	Adler	
4,106,813	A		8/1978	Goodbary	
4,120,409	A		10/1978	vander Werff	
4,194,450	A		3/1980	Miller	
4,222,334	A		9/1980	Peterson	
4,224,877	A	*	9/1980	Stark et al.	105/250
4,232,989	A		11/1980	Miller	
4,246,849	A	*	1/1981	Gramse	105/251
4,250,814	A		2/1981	Stark et al.	
4,252,068	A		2/1981	Nolan	
4,348,962	A	*	9/1982	Smith	105/248
4,361,097	A	*	11/1982	Jones et al.	105/406.1
4,484,527	A	*	11/1984	O'Hara	105/247
4,542,701	A		9/1985	Fischer et al.	
4,555,033	A		11/1985	Miller	
RE32,189	E	*	6/1986	Adler et al.	105/377.07
4,601,244	A		7/1986	Fischer	
4,637,320	A	*	1/1987	Paton et al.	105/406.1
4,740,130	A		4/1988	Prins	
4,800,820	A	*	1/1989	Tomaka	105/406.1
4,843,974	A		7/1989	Ritter et al.	
4,884,511	A		12/1989	Hallam et al.	
4,893,568	A	*	1/1990	Adams	105/416
4,898,101	A	*	2/1990	Harter	105/247
5,063,858	A		11/1991	Dugge	
5,086,709	A		2/1992	Fischer et al.	
5,144,895	A		9/1992	Murray	
5,163,372	A		11/1992	Galvan et al.	
5,181,474	A	*	1/1993	Miller	105/355
5,249,531	A		10/1993	Taylor	
5,261,333	A		11/1993	Miller	
5,813,353	A	*	9/1998	Sauter	105/406.1
5,823,118	A		10/1998	Manstrom	
6,604,469	B1		8/2003	Galvan et al.	
6,745,701	B2		6/2004	Elder	
7,080,598	B2	*	7/2006	Creighton et al.	105/247
7,367,272	B2		5/2008	Taylor	
7,681,507	B2	*	3/2010	Herzog et al.	105/286
7,735,426	B2	*	6/2010	Creighton et al.	105/286
7,780,021	B2		8/2010	Forbes	
2010/0251922	A1	*	10/2010	Forbes et al.	105/240

FOREIGN PATENT DOCUMENTS

CN	101486347		7/2009
EP	0543279	B1	5/1995
EP	1790547	A1	5/2007
EP	1798103	A1	6/2007
GB	1318571		5/1973
GB	2013598		8/1979

OTHER PUBLICATIONS

Drawing of QIT car dated Aug. 27, 2007.

2 Sheets of Details of End Structure of an Admitted Prior Art Grain Car of National Steel Car Showing End Post, Lateral Intermediate Stub Wall, Elephant Ears Arrangement and End Slope Sheet to Shear Plate Connection at least as early as Jan. 1, 2001.

Reproduction of Design Drawing of Dulth, Missabi & Iron Range (DM&IR) Open Topped Ore Hopper Car General Arrangement Drawing 8760 Drawn Apr. 8, 1950, (Quality Poor in Original), Showing Rear Draft Stops Extending Inboard of Truck Center.

Freight Cars: Hopper, Ore; Car Builders' Cyclopedia, 1937, pp. 313-320, 14th ed., Simmons-Boardman Publishing Corporation, New York, NY.

A.C.F. Covered and Open Top Hopper Cars; Car Builders' Cyclopedia, 1943, pp. 281-289, 16th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1957, pp. 265-272, 20th ed., Simmons-Boardman Publishing Corporation, New York, NY.

Freight Cars: Hopper, Ore, Class HMA; Car Builders' Cyclopedia, 1961, pp. 246-258, 21st ed., Simmons-Boardman Publishing Corporation, New York, NY.

Car and Locomotive Cyclopedia, 1966, 10 pp., 1st ed., Simmons-Boardman Publishing Corporation, New York, Ny.

* cited by examiner

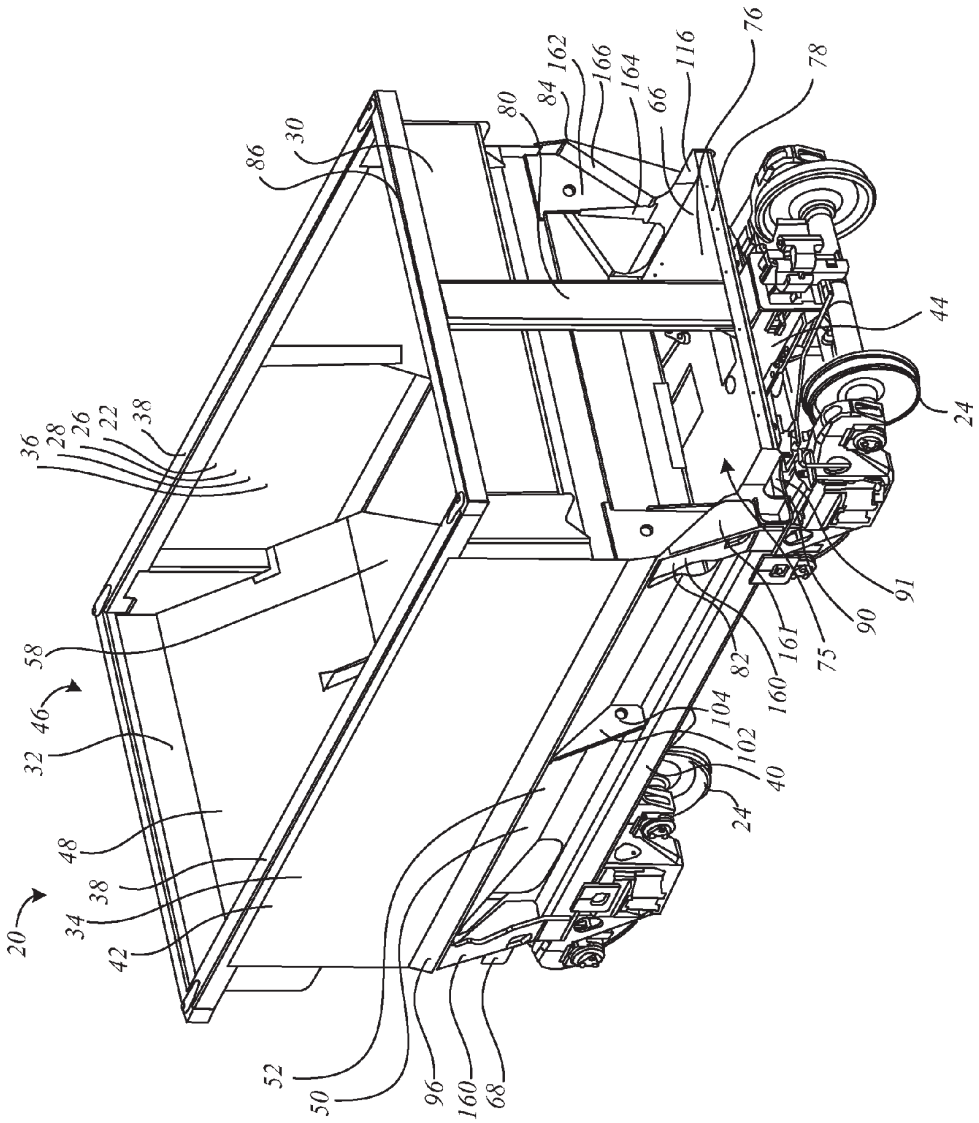

76
116
166
162
84
80
78
66
164
86
30
44
24
36
28
26
22
38
58
46
32
48
38
34
20
42
52
50
96
160
68
91
90
75
161
160
82
104
102
40
24

Figure 1

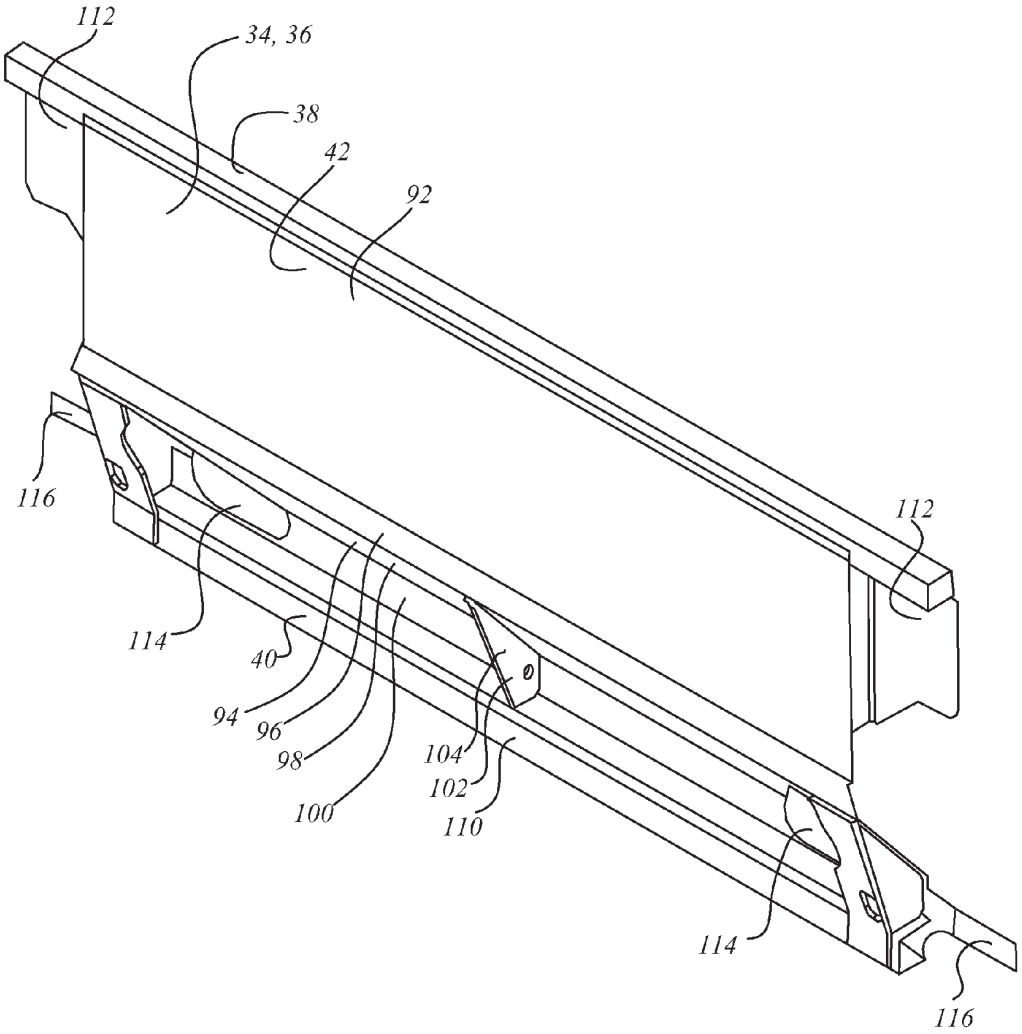


Figure 2a

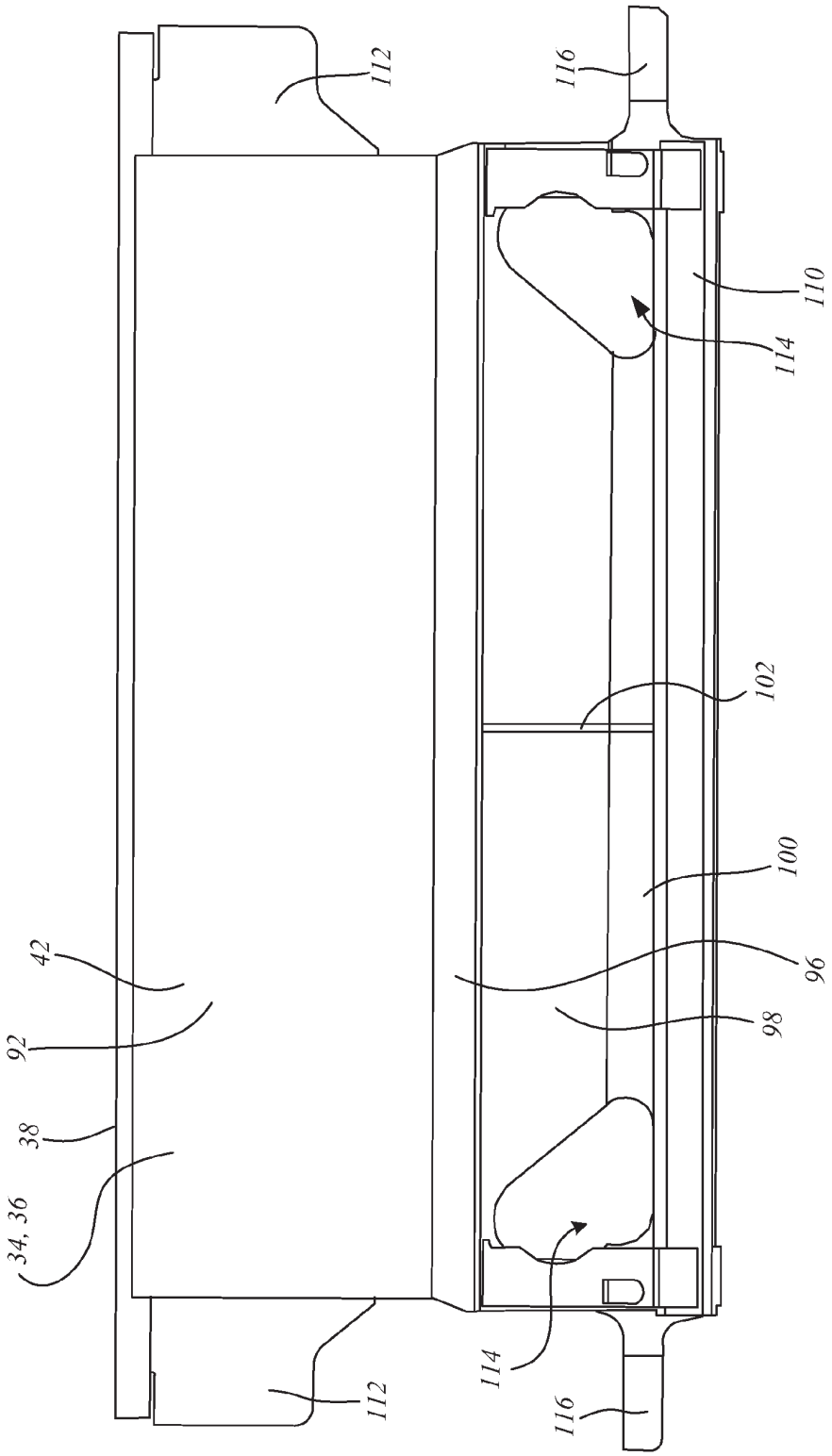


Figure 2b

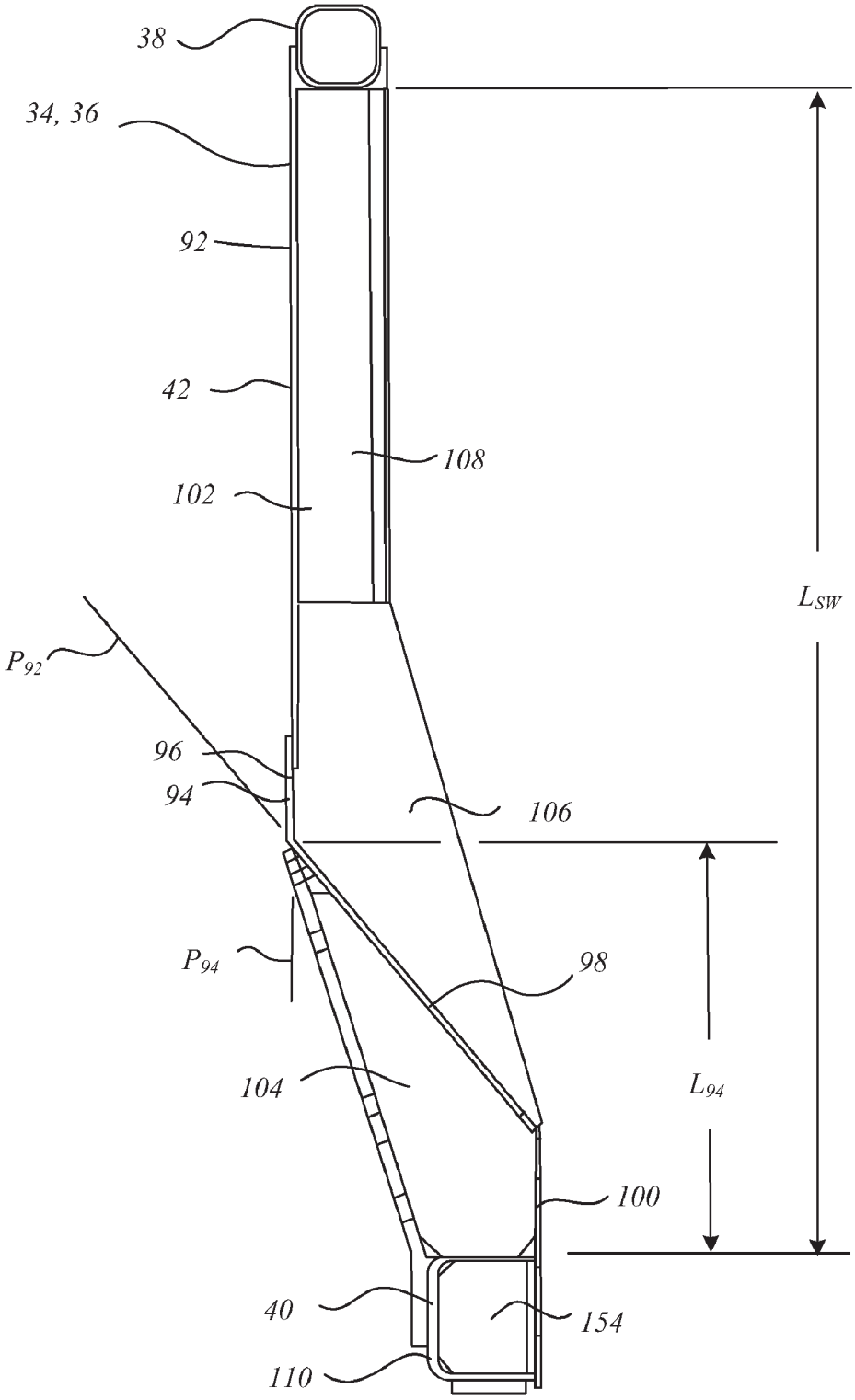

38
34, 36
92
42
108
102
L_{SW}
P_{92}
96
94
106
P_{94}
98
104
L_{94}
100
40
154
110

Figure 2c

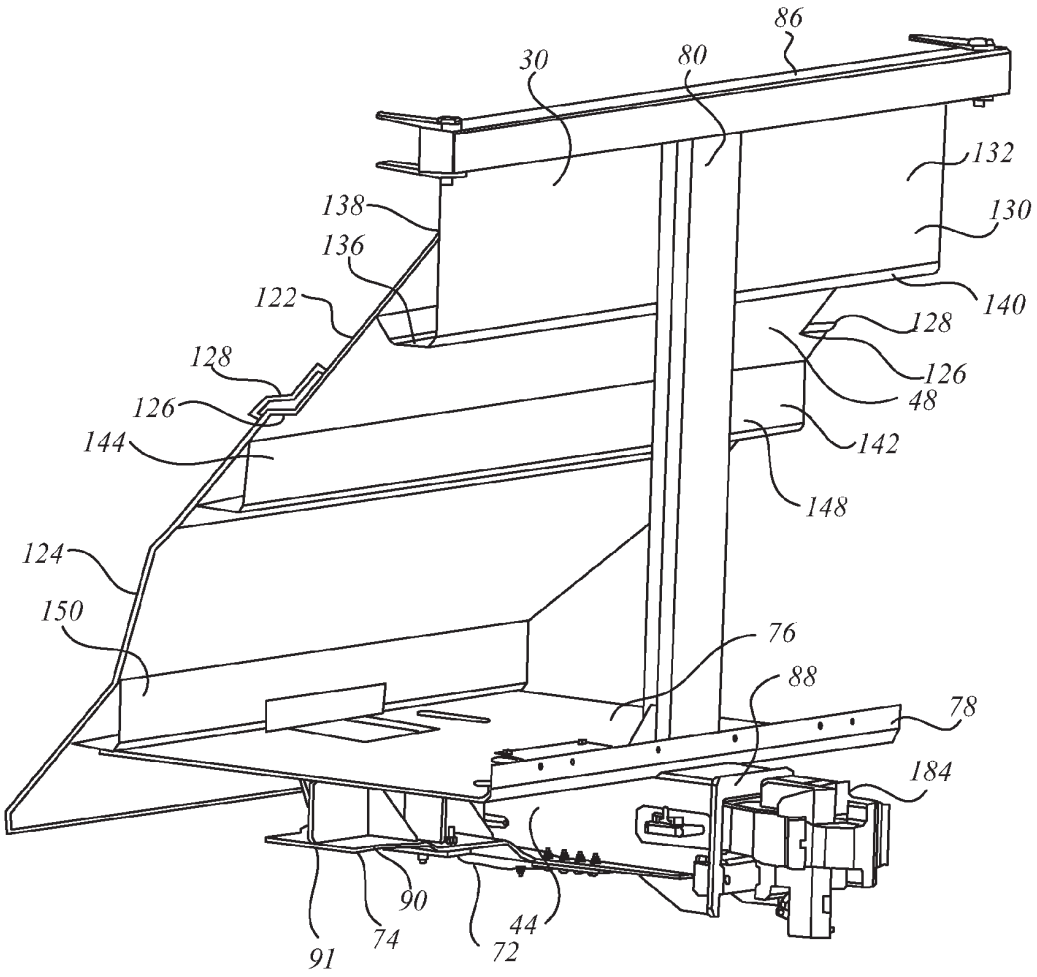

86
30
80
132
130
138
136
122
140
128
128
126
48
126
144
142
148
124
150
76
88
78
184
90
44
74
72
91

Figure 3a

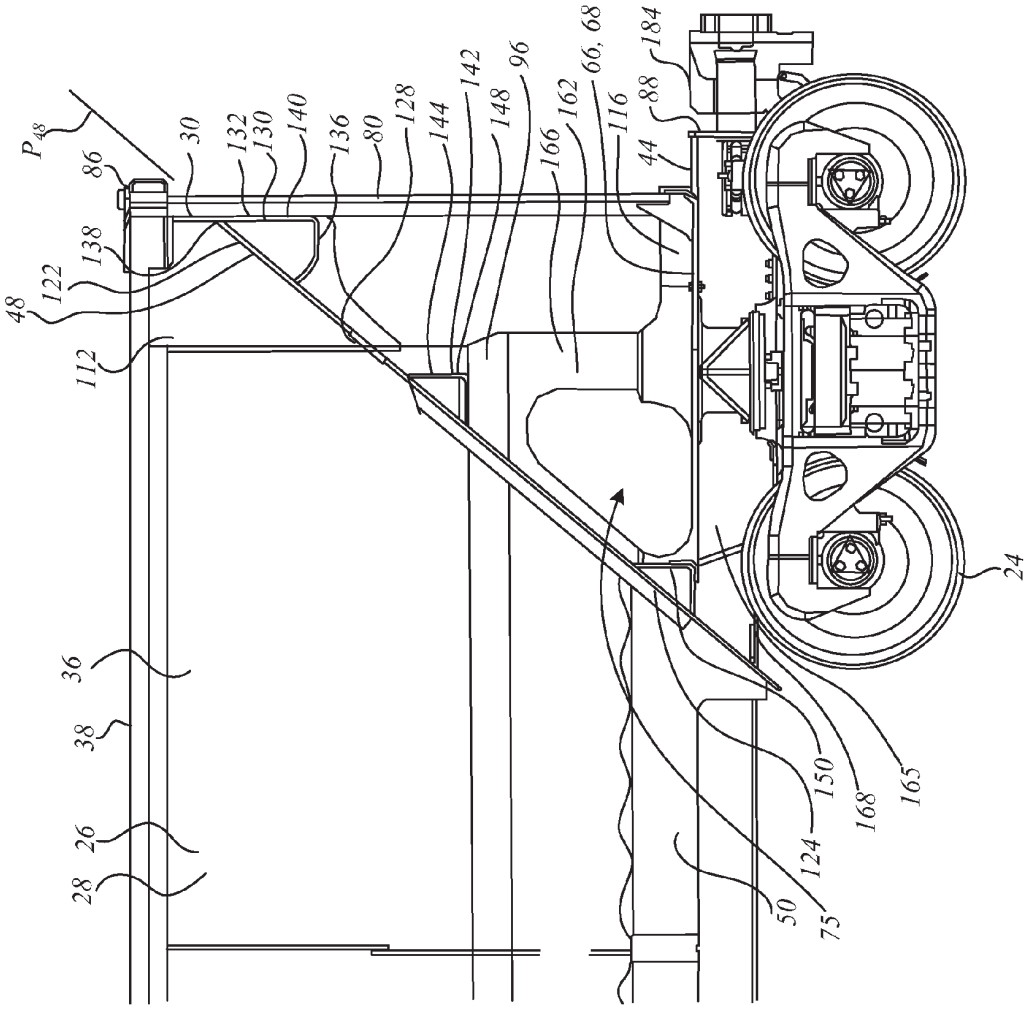

P_{48}
86
30
132
130
140
136
80
128
144
142
148
96
166
162
66, 68
116
88
184
44
138
122
48
112
36
38
26
28
24
150
168
165
124
50
75

Figure 3b

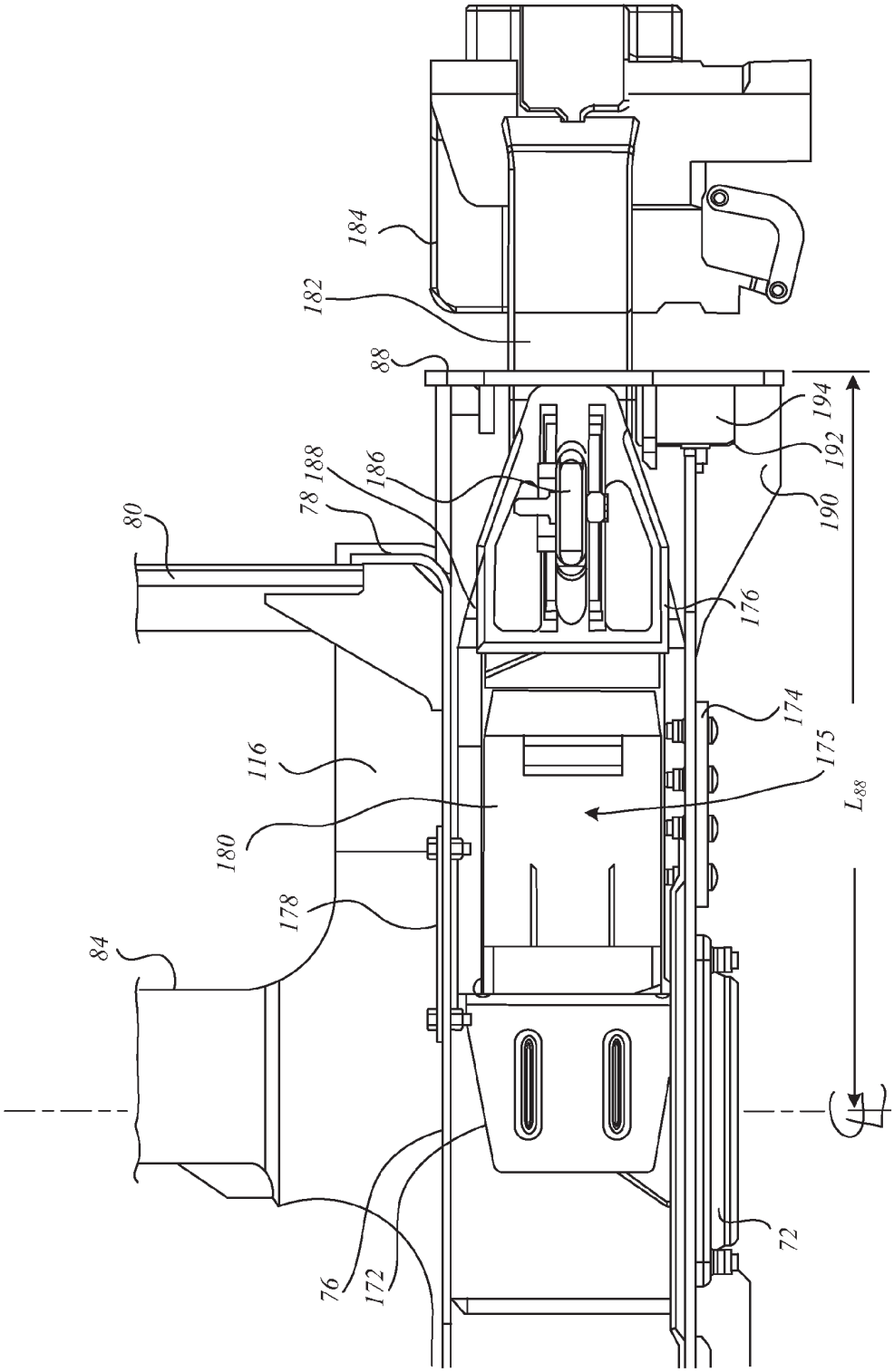

184
182
88
194
192
190
188
186
78
80
176
174
175
L_{88}
116
180
178
84
72
76
172

Figure 3c

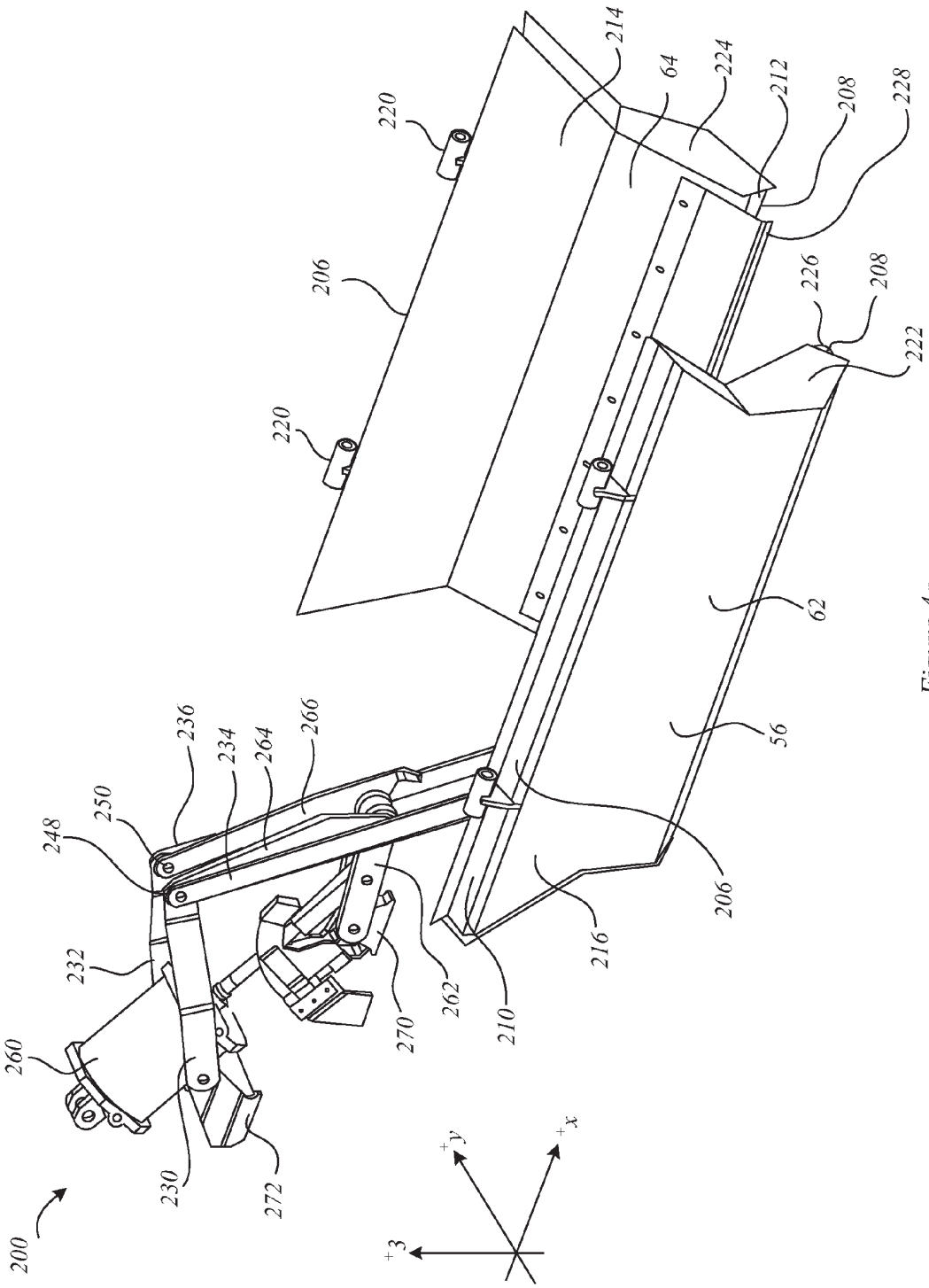

214
64
224
212
208
228
220
206
226
208
222
220
62
56
206
216
210
262
270
232
260
230
272
200
+y
+x
+3

Figure 4a

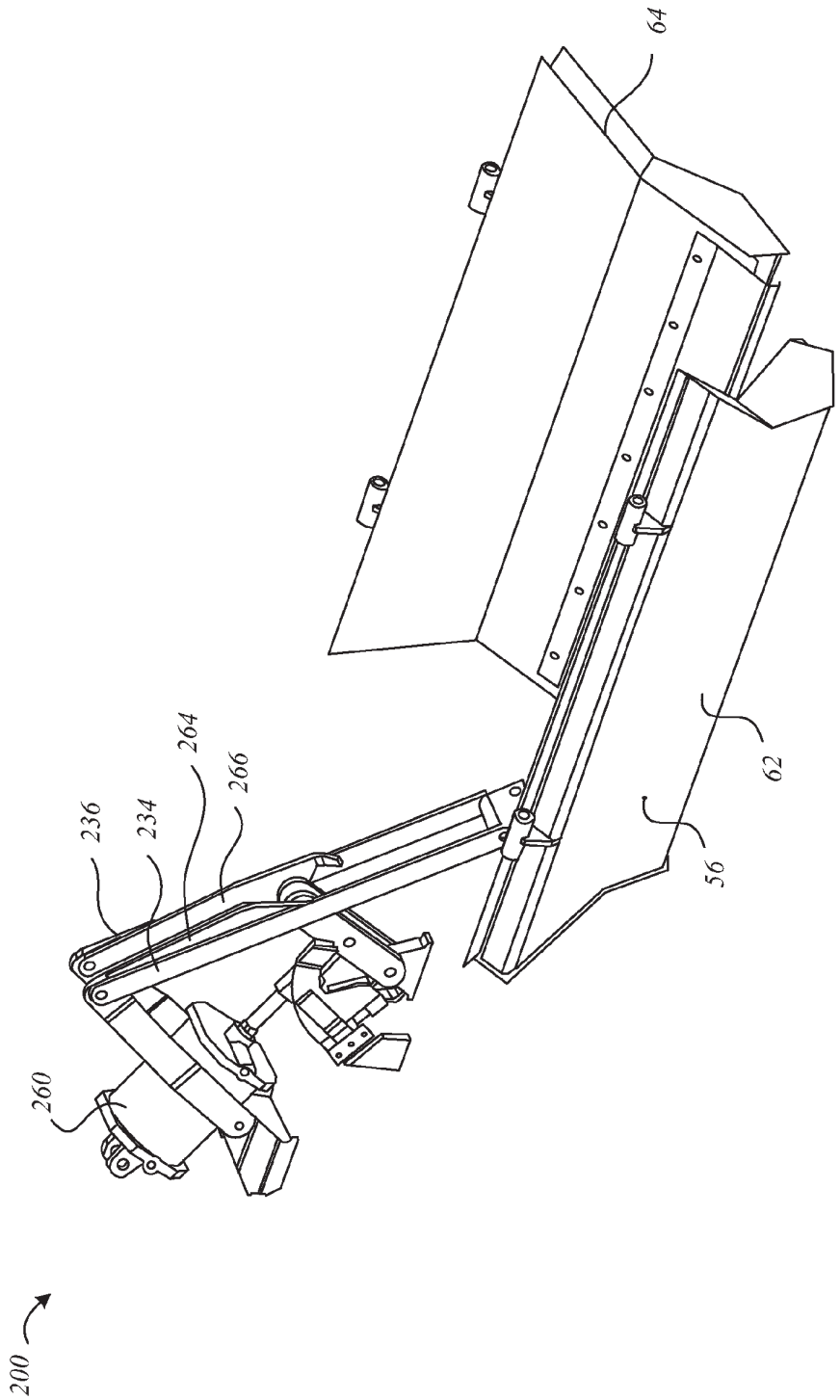


Figure 4b

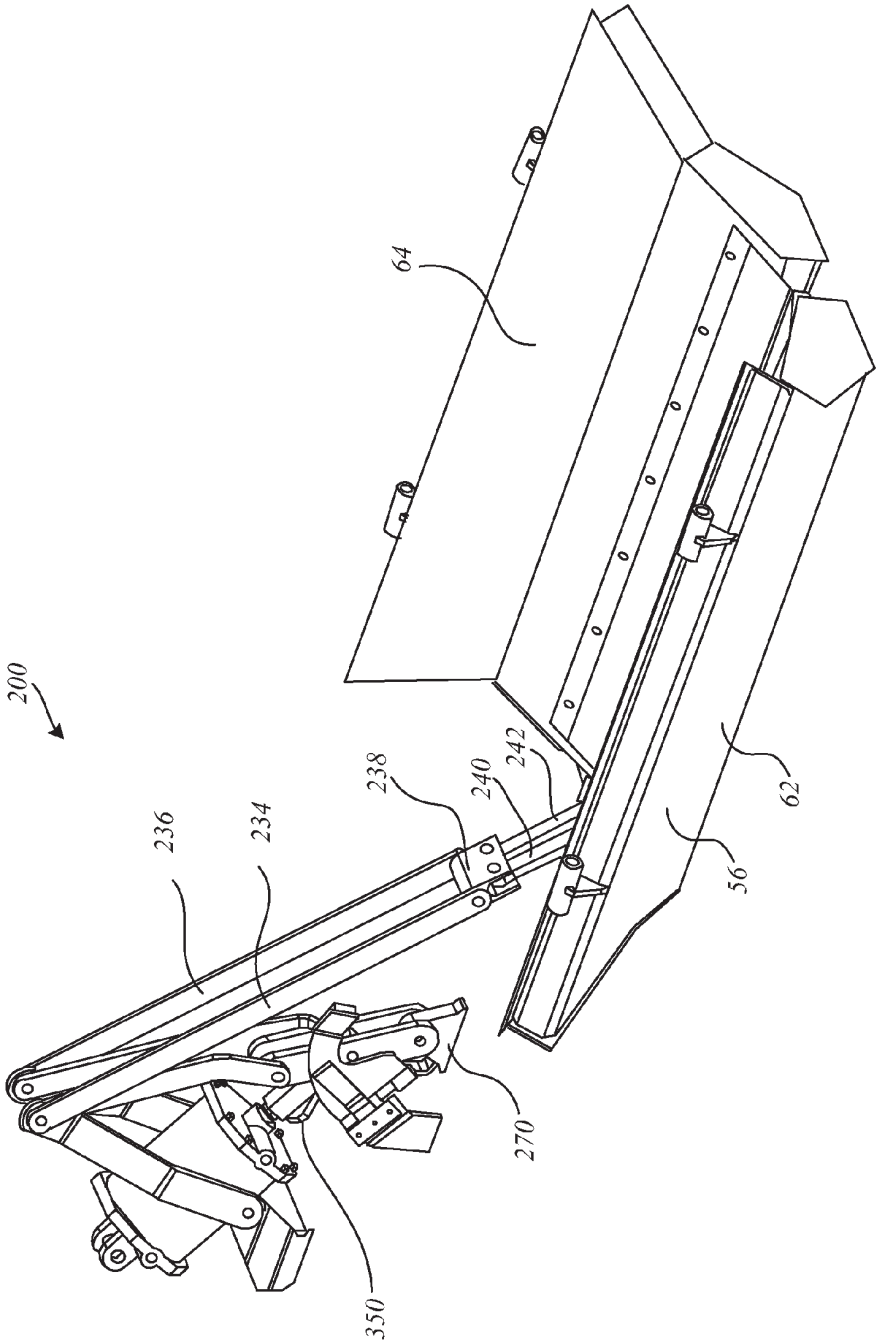


Figure 4c

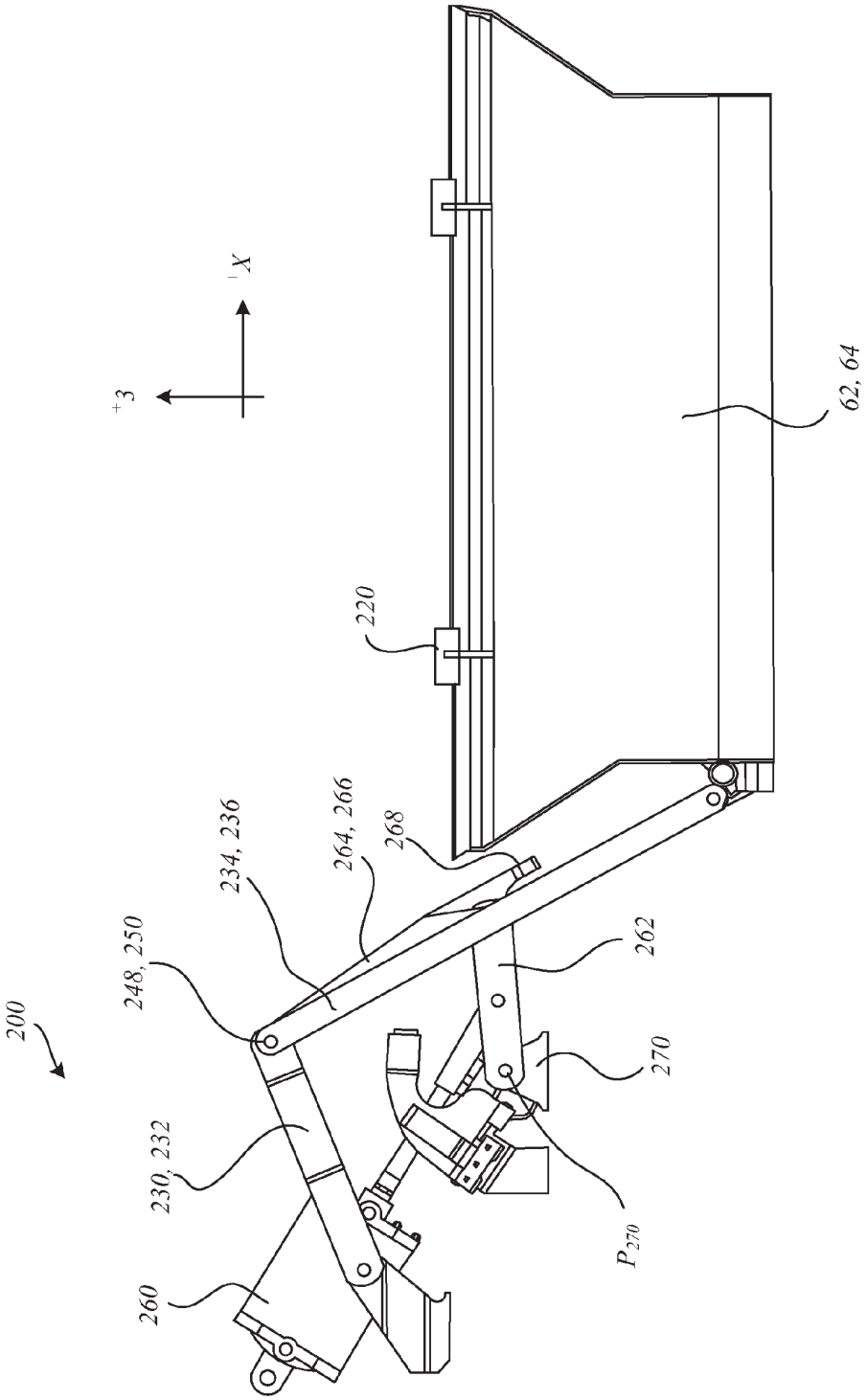

+X
+3
62, 64
220
264, 266
268
234, 236
248, 250
262
270
200
230, 232
260
P_{270}

Figure 5a

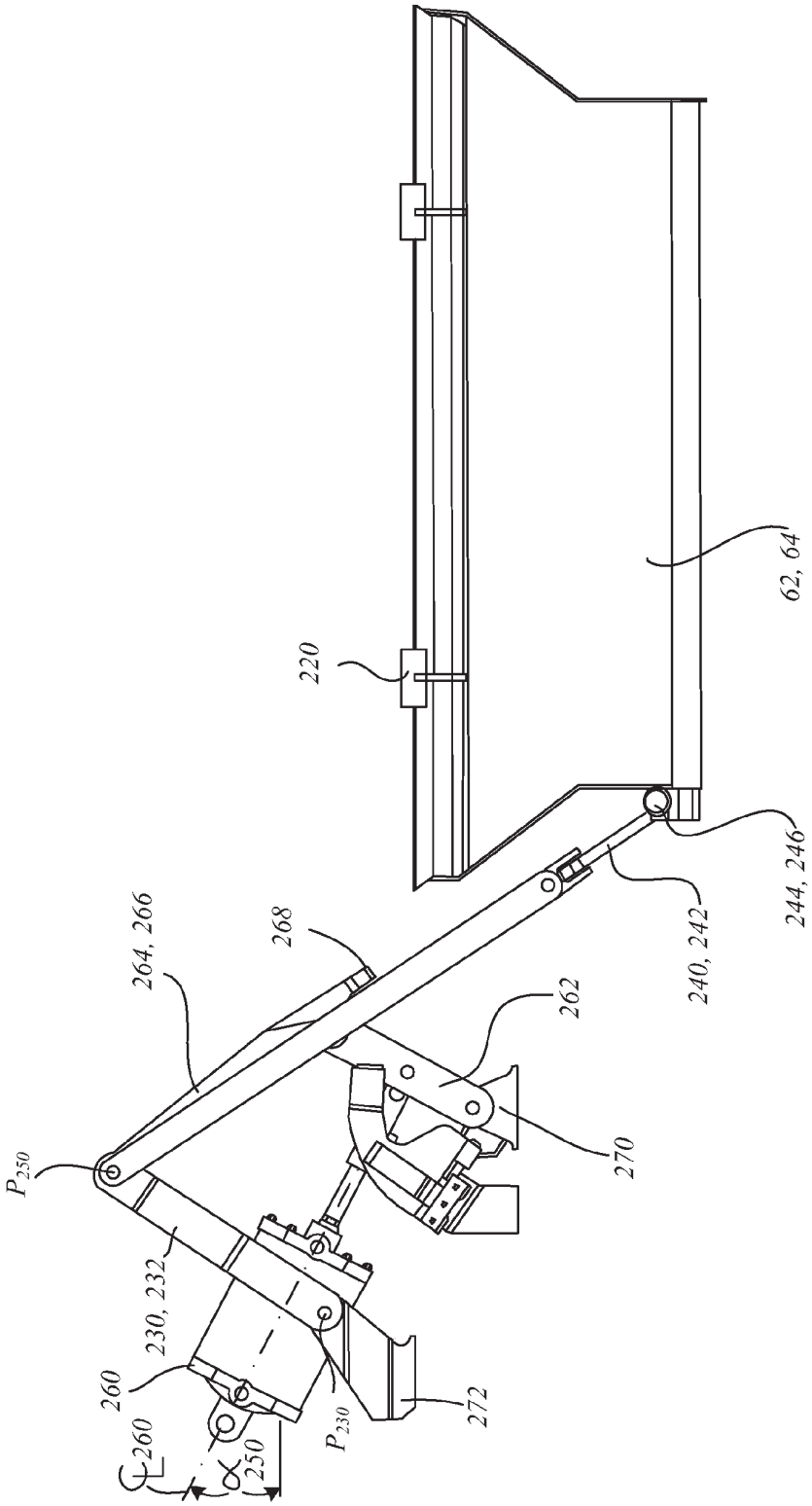

220
62, 64
244, 246
240, 242
268
264, 266
262
270
P_{250}
230, 232
260
260
250
P_{230}
272

Figure 5b

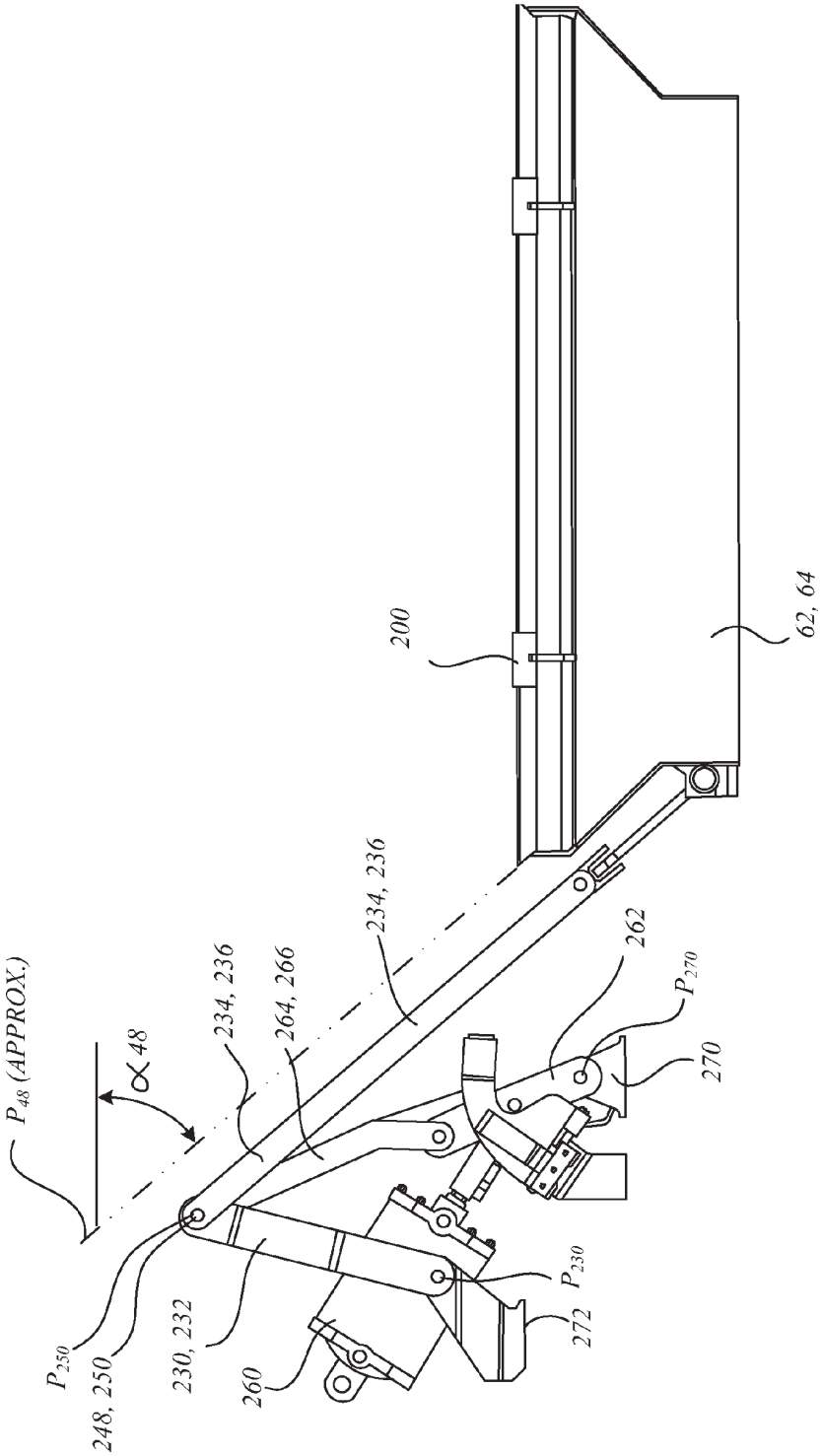

200
62, 64
234, 236
262
P_{270}
270
P_{48} (APPROX.)
48
234, 236
264, 266
P_{230}
272
P_{250}
248, 250
230, 232
260

Figure 5c

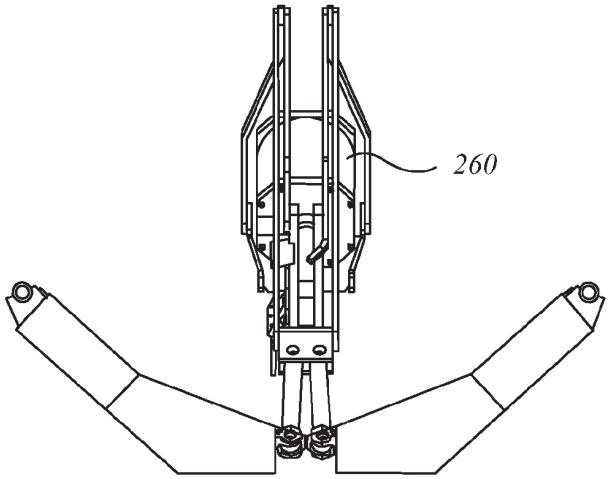


Figure 6c

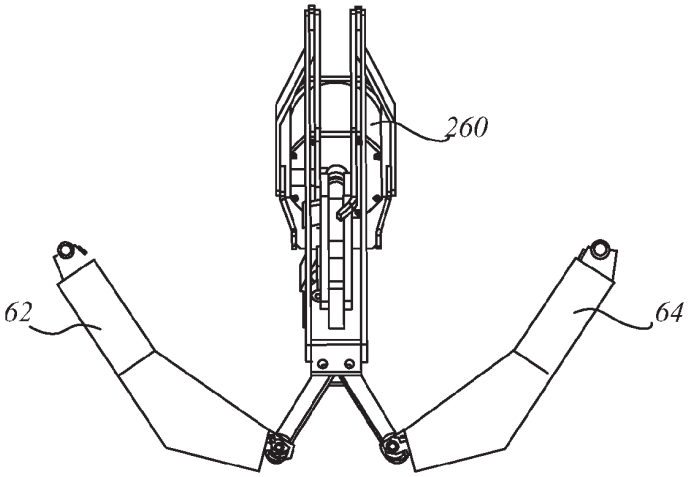


Figure 6b

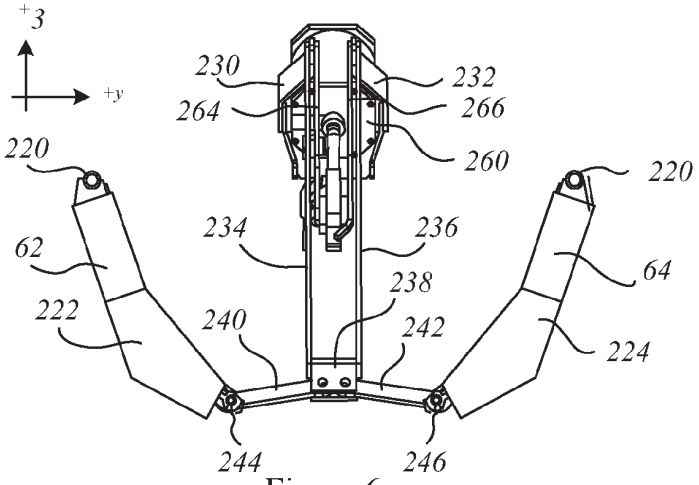


Figure 6a

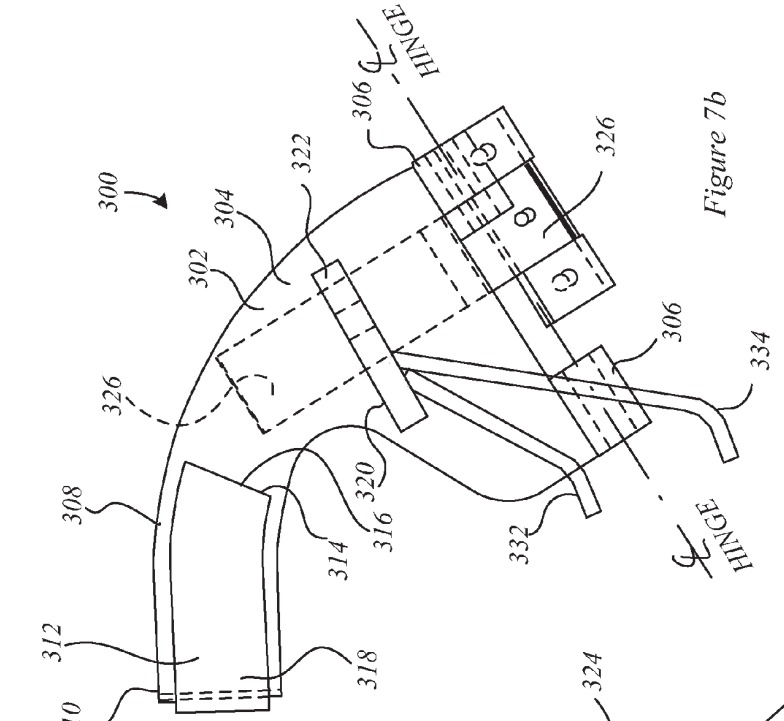


Figure 7b

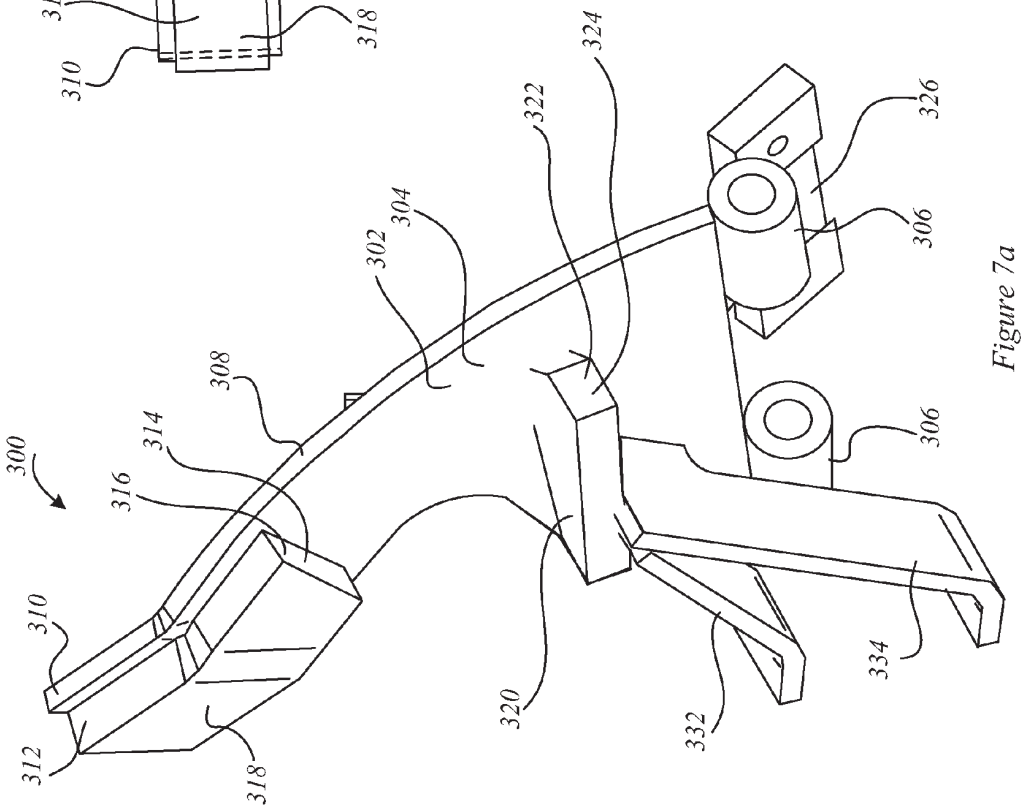


Figure 7a

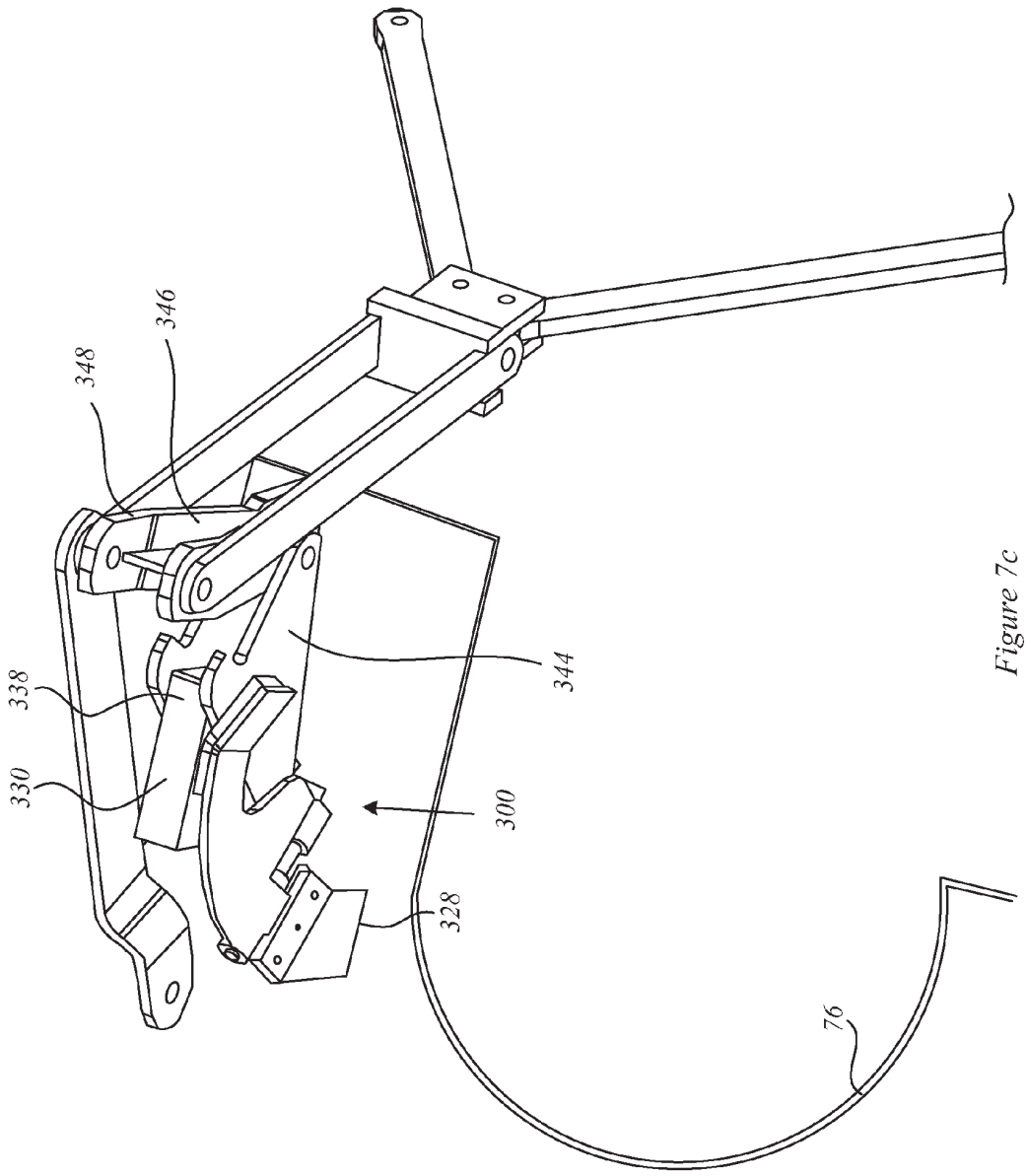


Figure 7c

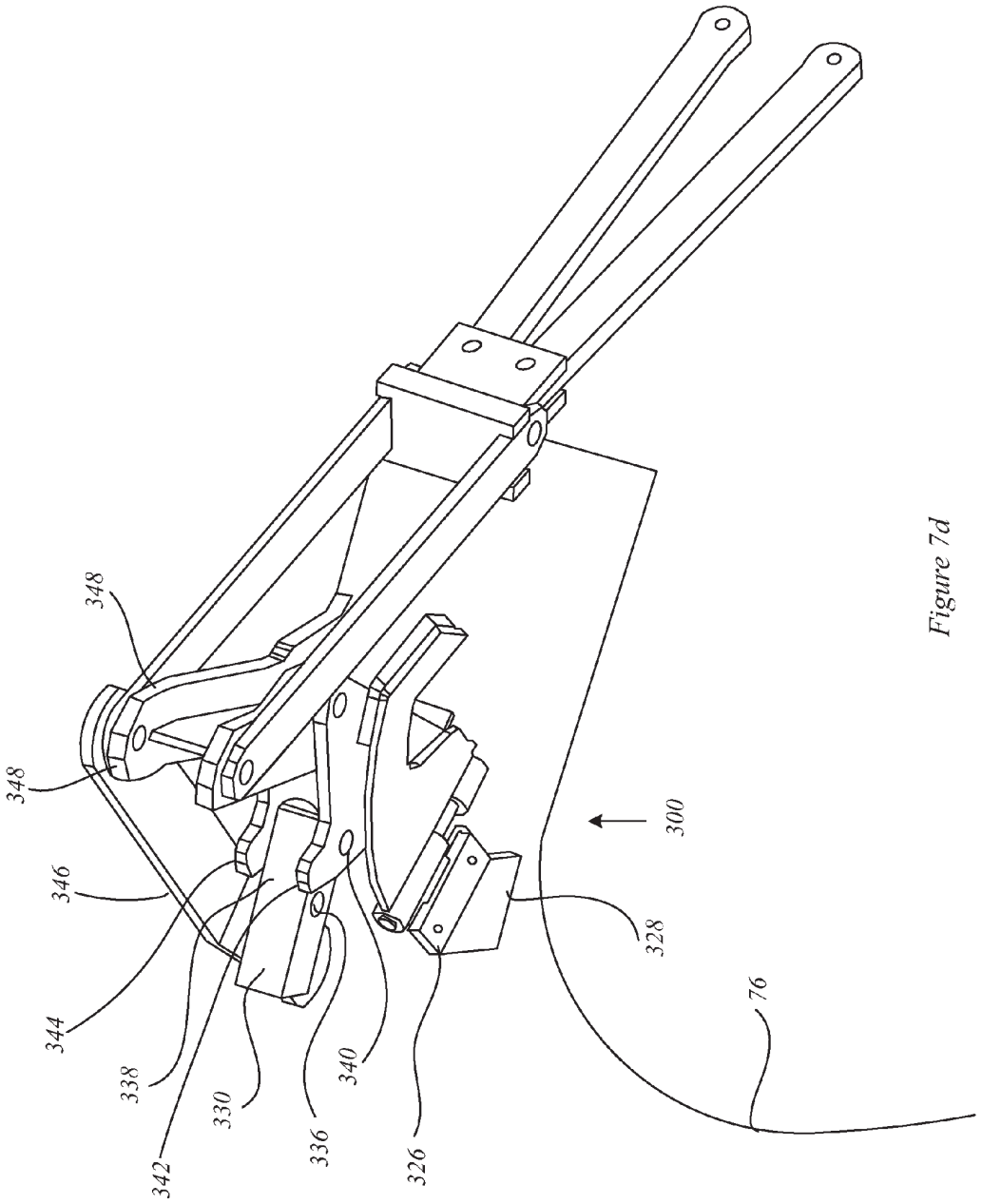


Figure 7d

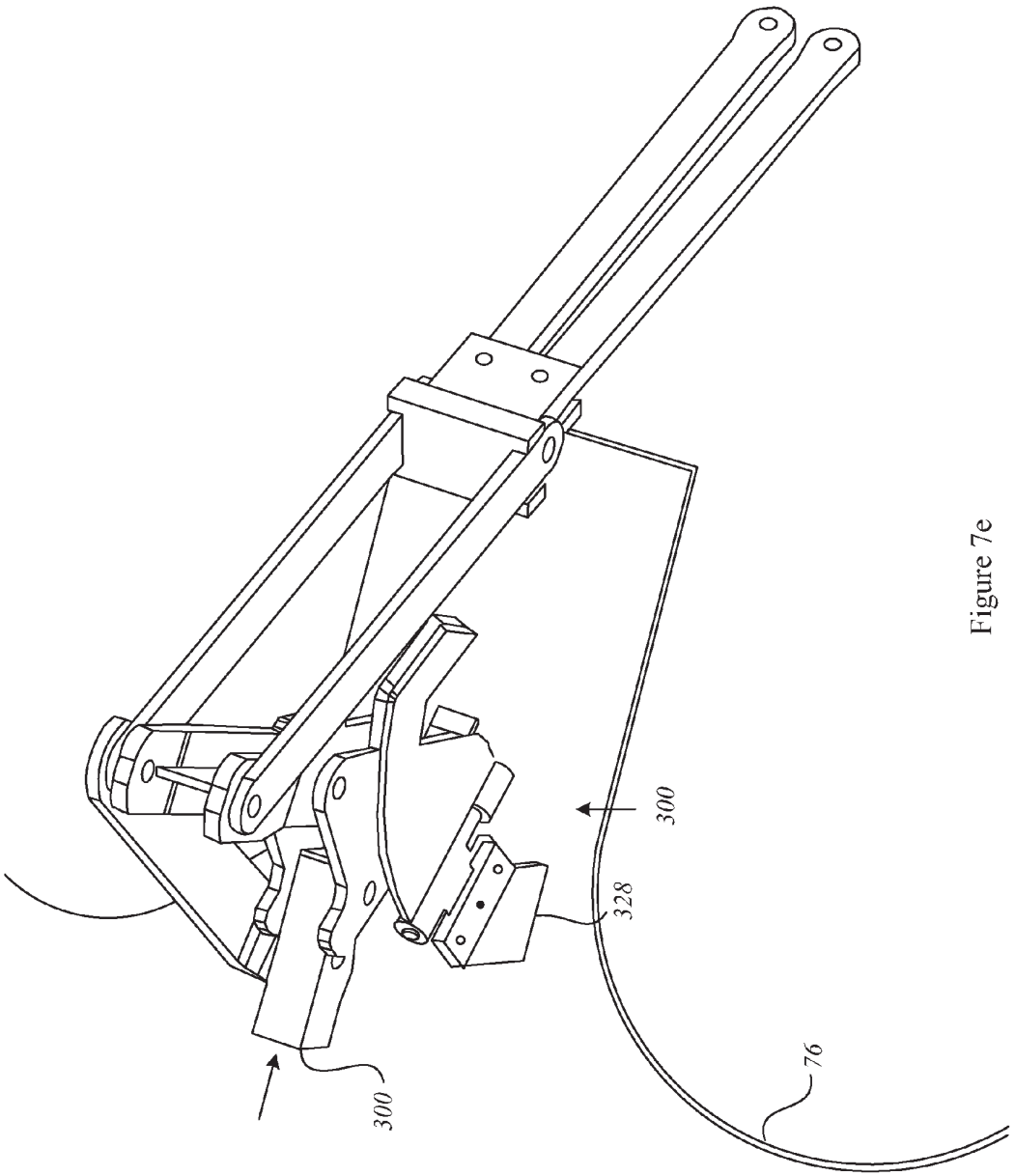


Figure 7e

RAILROAD GONDOLA CAR STRUCTURE AND MECHANISM THEREFOR

This application is a divisional application of U.S. patent application Ser. No. 12/559,065 entitled "Railroad Gondola Car Structure and Mechanism Therefor," filed Sep. 14, 2009, which claims priority under 35 USC 119 to Canadian Patent Application Serial Number 2,678,447, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 11, 2009, and Canadian Patent Application Serial Number 2,678,605, entitled "Railroad Gondola Car Structure and Mechanism Therefor" filed Sep. 14, 2009. U.S. patent application Ser. No. 12/559,065 is incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to the field of railroad freight cars, and, in particular to rail road gondola cars such as may employ bottom unloading gates or doors.

BACKGROUND

There are many kinds of rail road cars for carrying particulate material, be it sand or gravel aggregate, plastic pellets, grains, ores, potash, coal or other granular materials. Many of those cars have an upper opening, or accessway of some kind, by which the particulate is loaded, and a lower opening, or accessway, or gate, or door by which the particulate material exits the car under the influence of gravity. While the inlet opening need not necessarily have a movable gate, the outlet opening requires a governor of some kind that is movable between a closed position for retaining the lading while the lading is being transported, and an open position for releasing the lading at the destination. The terminology "flow through" or "flow through rail road car" or "center flow" car, or the like, may sometimes be used for cars of this nature where lading, typically particulate lading, is introduced at the top, and flows out at the bottom.

Discharge doors for gondola cars or other bottom dumping cars may tend to have certain desirable properties. First, to the extent possible it is usually desirable for the door opening to be large so that unloading may tend to be relatively fast, and for the sides of any unloading chute to be relatively steep so that the particulate will tend not to hang up on the slope. Further, to the extent that the door can be large and the slope sheets steep, the interior of the car may tend to have a greater lading volume for a given car length. Further still, any increase in lading achieved will tend to be at a relatively low height relative to Top of Rail (TOR) and so may tend to aid in maintaining a low center of gravity. A low center of gravity tends to yield a better riding car that is less prone to derailment, and perhaps less prone to cause as much wear or damage to tracks.

For a given length of car, hopper volume, and hence overall car volume, can be maximized by reducing the proportion of the length of the car occupied by the trucks, and occupied by the door opening drive mechanism. Furthermore, where the lading to be carried by the car is of greater than usual density, it may often be helpful for the truck center length to be relatively short such that the length of the span between the trucks is smaller, and the weight of the structure may be correspondingly decreased relative to the maximum permissible gross weight on rail for the car. In some instances, as with iron ore or other high density lading, that truck center distance may be very short.

It may also be that in some circumstances ore cars are used in quasi-permanent sets that form a unit train. The unit train may tend to follow a single route for substantially its entire operational service life. In the case of an ore car, that operational route may be from a mine or concentrator facility, at which the cars receive the lading; to a discharge facility, whether a mill or a break of bulk terminal at a port. In these circumstances the line may be owned by the mine or mill, and the cars may not necessarily be used for interchange service. To the extent that they are not used for interchange service they may not necessarily comply with all AAR standards. The cars may have short, possibly non-standard draft sills, draft gear, and couplers, or a combination thereof.

The cars may have tightly limited space envelopes over the end shear plates, and yet these spaces may nonetheless be intended to accommodate, for example, the brake reservoir and pneumatic gear for operating the gondola discharge doors.

SUMMARY OF THE INVENTION

In an aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a door movable between a closed position for retaining lading and an open position for permitting egress of lading. The hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has at least a first end slope sheet inclined downwardly in the lengthwise direction toward the door. There is a linkage connected to the door. The linkage is oriented lengthwise with respect to the car. A drive is connected to the linkage. The drive is operable to move the linkage and thereby to urge the door to a closed position. The linkage is movable from a first position corresponding to the open position of the door to a second position corresponding to the closed position of the door. The linkage includes at least a drag link. When the linkage moves from the first to the second position one of (a) the overall motion from the first to the second position includes displacement of the drag link in a direction having a predominant component of motion parallel to the first end slope sheet; and (b) the motion of the drag link is at least instantaneously parallel to the first end slope sheet.

In another feature of that aspect of the invention the linkage includes a first pivot arm pivotally connected to a datum structure at a first pivot connection. The drive is also mounted to the datum structure. The linkage includes a second pivot arm pivotally connected to the datum structure at a second pivot connection. The second pivot arm has the door mounted thereto. The first pivot arm has a second connection distant from the first pivot connection. The second pivot arm has a second connection distant from the second pivot connection. A mechanical transmission is mounted between the second connection of the second pivot arm and the second connection of the first pivot arm. The mechanical transmission includes the drag link. The drive is connected to move the first pivot arm, and, in moving from the first position to the second position, each position of the first pivot arm being associated with a unique position of the drag link. In a further feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand

door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. Each second pivot arm has a respective second connection distant from the respective second pivot connection. A mechanical transmission is mounted between the respective second connections of the second pivot arms and the respective second connections of the first pivot arms. The drag link is a left hand drag link, and the mechanical transmission includes a mated parallel right hand drag link. The left and right hand drag links each have a first end mounted to one of the respective second connections of the first pivot arms. The left and right hand drag links have second ends yoked together distantly from the first ends. The transmission member includes left and right hand slave links extending between and connecting the second ends of the drag links to the second connections of the second pivot arms respectively.

In still another feature, the linkage includes left and right hand first pivot arms pivotally connected to a datum structure at respective first pivot connections, the respective first pivot connections being co-axial. The linkage includes left and right hand second pivot arms pivotally connected to the datum structure at respective second pivot connection. The door is a left hand door of a pair of co-operable right and left hand doors, the left hand door being mounted to the left hand second pivot arm and the right hand door being mounted to the right hand second pivot arm. Each first pivot arm has a respective second connection distant from its respective first pivot connection, the respective second connections being pivot connections and being mutually co-axial. The left and right hand pivot arms co-operate to define a bifurcated lever straddling the drive. In yet another feature, the drive includes an actuating cylinder having an axially reciprocating member, the axially reciprocating member being inclined relative to horizontal. In still another feature the drag link lies between the actuating cylinder and the first end slope sheet of the hopper. In another feature the railroad hopper car includes a first end section, the first end section includes a draft sill and a substantially horizontal shear plate mounted over the draft sill, the drive includes an actuating cylinder having an axis of reciprocation lying in a central vertical-lengthwise plane of the car, the actuating cylinder is mounted above the shear plate, the first end slope sheet at least partially overhangs the actuating cylinder; and the drag link is located between the actuating cylinder and the first slope sheet.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. The car includes structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. A door operating linkage is connected to the gate, the door operating linkage being oriented lengthwise with respect to the car. An actuating cylinder connected to drive the door operating linkage, the actuating cylinder also being oriented to act lengthwise with respect to the car, the actuating cylinder having an axis of reciprocation. The axis of reciprocation being tilted such that displacement of the actuating cylinder includes a vertical component of motion.

In another feature of that aspect of the invention, the hopper car includes an end section mounted over one of the trucks, the end section includes a substantially horizontal shear plate, and the actuating cylinder is mounted on a pedestal mounted to the shear plate, the pedestal including an inclined mounting for the cylinder. In a further feature, the railroad hopper car has a longitudinal-vertical central plane, and the axis or reciprocation lies in the longitudinal-vertical plane. In a still further feature, the hopper includes at least a first end slope sheet extending longitudinally and being inclined longitudinally inboard and downwardly toward the gate, and at least part of the actuating cylinder is overhung by at least part of the first end slope sheet. In a yet further feature, the hopper car includes an end section having a substantially horizontal shear plate mounted over a draft sill. The hopper includes a first end slope sheet, the first end slope sheet at least partially overhanging the horizontal shear plate. The actuating cylinder is mounted above the shear plate, centrally aligned over the draft sill. The actuating cylinder is at least partially overhung by the first end slope sheet. In still yet another further feature the first slope sheet is substantially planar and has a first angle of inclination relative to horizontal. The actuating cylinder is inclined longitudinally inboard downwardly, and is inclined at a second angle. The second angle lies between horizontal and the first angle. In yet another feature the car has an underframe and the door operating linkage includes a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, the first pivot linkage being a first pivot arm constrained to pivot on an axis of rotation oriented horizontally cross-wise relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and includes at least the gate. The third linkage component includes a drag link element connected to the first pivot arm, the drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator. In still another feature the main pivot connection of the first pivot arm to the first linkage component is located lower than the actuating cylinder. In yet still another feature, the drag link element is connected to the first pivot arm at a distal pivot connection relative to the main pivot connection, and, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection.

In another aspect there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge including a gate movable between a closed position for retaining lading and an open position for permitting egress of lading. It has first and second end sections to which the hopper is mounted, the first and second end sections being mounted to respective first and second railroad car trucks for rolling motion along railroad tracks in a lengthwise direction of the car. There is a door operating linkage connected to the gate, the door operating linkage being oriented lengthwise with respect to the car and connected. An actuating cylinder is connected to drive the door operating linkage. The actuating cylinder is also oriented to act in a lengthwise extending plane with respect to the car. The actuating cylinder has an axis of reciprocation. The door operating linkage includes a first pivot arm pivotally mounted to the first end section at a first pivot connection. There is a mechanical transmission connected between the first pivot arm and the gate. The mechanical transmission includes at least a drag link movably connected to the first pivot arm at a location distant from the first

pivot connection. The first pivot connection is lower than the actuating cylinder as seen when viewing the first end section in side view.

In another feature of that aspect of the invention, when the gate is in the closed position and the car is viewed in side view, the actuating cylinder is located between the main pivot connection and the distal pivot connection. In still another feature, the actuating cylinder drives an intermediate lever that is connected to drive the first pivot arm.

In another aspect of the invention there is a rail road hopper car. It has a hopper carried between a pair of trucks, the hopper having first and second upstanding sidewalls running lengthwise therealong. The hopper has a lower discharge and convergent slope sheets giving onto the discharge. The rail road car has a side sill and a top chord. The first upstanding sidewall extends from the side sill to the top chord. The first upstanding sidewall has a predominantly upwardly running sidewall stiffener mounted thereto. The sidewall stiffener is located at a longitudinal station intermediate the trucks. The first upstanding sidewall has a first region, the first region being a lower region thereof. The first upstanding sidewall has a second region. The second region is an upper region thereof. The sidewall stiffener has a first portion, the first portion being a lower portion thereof. The first portion is mounted to the first region of the first upstanding sidewall. The sidewall stiffener has a second portion, the second portion being an upper portion thereof. The second portion is mounted to the second region of the upstanding sidewall. The first portion of the first upstanding sidewall stiffener is laterally outboard of the first region of the first upstanding sidewall. The second portion of the sidewall stiffener is laterally inboard of the second region of the first upstanding sidewall. The sidewall has a continuous section between the first and second regions thereof. The sidewall stiffener has web continuity between the first and second portions thereof.

In a feature of that aspect of the invention, the first and second portions of the sidewall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof, and the stiffener has vertical web continuity through the transition portion. In another feature, the first upstanding sidewall has a third region intermediate the first and second regions. The third region includes a side sheet transition portion passing across the sidewall stiffener from an inboard margin thereof to an outboard margin thereof. The hopper includes first and second sloped side sheets. The first sloped side sheet meets the first sidewall at the transition portion. In another feature, the first sidewall has an overall height from the side sill to the top chord, L, and the transition is located a distance above the side sill that is in the range of ¼ to ⅔ L. In a still further feature the first sidewall has an overall height from the side sill to the top chord, L, and the first slope sheet meets the transition at an height that is in the range of ¼ to ⅔ L above the side sill.

In a further aspect of the invention there is a railroad hopper car. It has at least one hopper having a bottom discharge, the bottom discharge having a bottom discharge governor movable between a closed position for retaining lading and an open position for permitting egress of lading. The car has structure by which the hopper is carried on spaced apart railroad cars trucks for rolling motion along railroad tracks in a lengthwise direction of the car. The hopper has a door operating linkage oriented lengthwise with respect to the car. There is an actuating cylinder also oriented to act in a lengthwise extending plane with respect to the car, the actuating cylinder being connected to drive the door operating linkage. The door operating linkage includes a pair of first and second linkage members co-operably mounted to either transverse side of the actuating cylinder, whereby the actuating cylinder is bracketed by the linkage members.

In another feature of that aspect of the invention, the car has an underframe and the linkage is a closed loop bar linkage in which there is a first linkage component, a second linkage component, a third linkage component, and a fourth linkage component. The first linkage component is a reference datum component and includes structure immovable relative to the underframe. The second linkage component is a first pivot linkage mounted to the first linkage component at a main pivot connection, and which includes the first and second linkage members, the first and second linkage members being a matched pair of left and right hand pivot arms constrained to pivot on a common axis of rotation relative to the underframe. The fourth linkage component is a second pivot linkage pivotally mounted to the first linkage component and which includes at least one pivotally mounted door assembly defining the bottom discharge governor. The third linkage component includes a drag link element having at least a first pivotal attachment to at least a portion of the fourth linkage component, whereby input motion of the second linkage component uniquely determines position and motion of the third and fourth linkage components relative to the first linkage component. Motion of the second linkage component is driven by the actuator.

In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. Displacement of the third linkage component associated with motion of the door assembly between the open position is predominantly in a direction generally parallel to the end slope sheet. In another feature the hopper includes a hopper end slope sheet. The end slope sheet extends substantially in a plane inclined downwardly and lengthwise inwardly toward the bottom discharge. During at least an instantaneous portion of motion of the third linkage component while the door assembly is in a position between the open position and the closed position the third linkage component moves parallel to the end slope sheet. In still another feature the third linkage component includes at least a first element and a second element mounted thereto. The first element is pivotally mounted to the first linkage component, and is constrained to move in a lengthwise-vertical plane relative to the first linkage component. The second element has a first connection to the first component the first connection being a pivot connection. The second element has a second connection to the fourth linkage component, the second connection having at least one degree of freedom of motion. The second element is constrained always to be co-planar with the first connection, the second connection, and the main pivot connection. In yet still another feature, the bottom discharge governor includes a door. The actuating cylinder is connected to drive the door operating linkage through a lever assembly. The lever assembly has an over-center lock that is operable to prevent release of the bottom gate to the open position when the actuating cylinder is inactive. In yet a further feature, motion of the first pivot linkage occurs in a longitudinal-vertical plane. The second pivot linkage moves in a plane generally cross-wise to the longitudinal-vertical plane. In still a further feature the main pivot connection is beneath the actuating cylinder when the hopper car is seen in side view. In again another feature one of (a) the main

pivot is beneath the drag link element; and (b) the actuating cylinder is between the main pivot and the drag link element. In a yet still further feature, the hopper includes at least a first end slope sheet, and the bottom discharge governor includes a door. The first end slope sheet is inclined longitudinally downwardly and inboard toward the door. The drag link element is inclined on a slope predominantly parallel to, and adjacent to, the first end slope sheet. The actuating cylinder is oriented along the lengthwise direction, and is also tilted longitudinally downwardly and inwardly toward the door.

In another aspect of the invention there is a railroad hopper car. It has at least one hopper carried by railroad car trucks for motion in a lengthwise direction of the car along railroad tracks. The hopper has a bottom discharge. The bottom discharge has a door movable between a closed position for retaining lading and an open position for permitting egress of lading. A mechanical transmission is connected to the door. The mechanical transmission is oriented lengthwise with respect to the car. A door actuator is connected to the mechanical transmission and is operable to urge the door from the open position toward the closed position, the door actuator being oriented to reciprocate in a first direction. The hopper car has a first lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. The hopper car has a second lock operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator.

In another feature of that aspect of the invention, the car has a central lengthwise-vertical plane, the door actuator is positioned to reciprocate in the central lengthwise-vertical plane, and the second lock is movable between the engaged and disengaged positions in motion predominantly transverse to the central lengthwise-vertical plane. In another feature, the second lock is mounted on an hinge and pivots in a circumferential direction between the engaged and disengaged positions. In still another feature the second lock is mounted on an hinge, the hinge has an axis lying parallel to the lengthwise vertical plane, and the second lock pivots circumferentially between the engaged and disengaged positions. In another feature, the second lock is biased toward the engaged position. In still another feature, the second lock is biased toward the engaged position. In yet another feature the apparatus is one in which one of: (a) the second lock has a cam and the actuator has a mating cam follower; and (b) the second lock has a cam follower and the actuator has a mating cam. The cam and cam follower are co-operable, and are oriented to deflect the second lock away from the engaged position as the door moves from the open position to the closed position thereof.

In another aspect of the invention, there is a lock mechanism for a door actuating transmission of a railroad gondola car, the door actuating transmission including a reciprocating actuating cylinder mounted to a datum structure, the cylinder being movable forward and backward in an axial direction. The lock mechanism has a body having a first fitting, a second fitting and a third fitting. The first fitting is a mounting by which to connect the lock mechanism to the datum structure. The second fitting is one of (a) a cam for co-operation with a member of the door actuating transmission, that member being a cam follower; and (b) a cam follower for co-operation with a member of the door actuating transmission, that member being a cam. The third fitting includes an abutment for co-operation with a mating fitting of the door actuating transmission. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction.

In another feature, the lock mechanism there has a bias member oriented to urge the third fitting toward the first position thereof. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure. In another feature, the first degree of freedom of motion is an angular degree of freedom, and the predominantly cross-wise motion is predominantly circumferential motion about an axis of rotation. In a feature the first fitting is an hinge, the axis of rotation is an axis of rotation of the hinge, and the axis of rotation of the hinge is substantially parallel to the axial direction of the door actuating transmission. In still another further feature, the first fitting of the lock mechanism includes an hinge and a footing of the hinge for mounting to the datum structure. The axis of rotation is an axis of rotation of the hinge, and the footing has a substantially planar footprint. The axis of rotation of the hinge is angularly inclined relative to the substantially planar footprint. In yet another feature, the lock mechanism has all or any combination of the forgoing additional features.

In still another aspect of the invention there is a railroad hopper car for carrying particulate material. The hopper car there has a hopper and first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction. The hopper is suspended between the first and second end sections. The hopper has a discharge section through which to release lading, and first and second end slope sheets oriented toward the first and second end sections, the slope sheets being inclined in the longitudinal direction to feed the discharge section. The first end section includes a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to either side of the draft sill, and a shear plate mounted to the draft sill and to the main bolster. The shear plate extends lengthwise along the draft sill and cross-wise from side to side of the hopper car. The first end slope sheet of the hopper overhangs the shear plate of the first end section. The hopper car is free of primary structure directly above the shear plate of the first end section under the overhang of the first slope sheet of the hopper.

In another feature of that aspect of the invention, there is one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall. In another feature, the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post

is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. In a further feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet.

In still another feature, the bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. In another feature, one of: (a) the first slope sheet has an upper margin and the hopper car includes an end post extending upwardly from the draft sill to the upper margin of the slope sheet; and (b) the first slope sheet has an upper margin terminating at an end wall, and the hopper car includes an end post extending upwardly from draft stub sill to the end wall; the shear plate has a longitudinally outboard margin and the draft sill has a striker located outboard of the longitudinally outboard margin of the shear plate, and the end post is one of: (a) rooted to the draft sill adjacent to the striker; (b) rooted to the shear plate adjacent to the longitudinally outboard margin of the shear plate. The bolster has first and second laterally outboard distal ends, and the hopper car has corner posts extending upwardly from the distal ends of the hopper to the first slope sheet. The hopper car has a machinery space bounded by (a) the first slope sheet; (b) the shear plate of the first end section; (c) the end post; and (d) the corner posts, and the machinery space is free of any other primary structure.

In yet another feature the hopper car has at least one longitudinally hinged discharge door, the discharge door being movable cross-wise between open and closed positions. A longitudinally acting pneumatic actuator is at least partially lodged in the machinery space directly above the draft sill. In still yet another feature a brake reservoir is also at least partially lodged in the machinery space. In a yet further feature the shear plate is mounted above and to the main bolster and defines an upper flange thereof. The main bolster has a lower flange downwardly spaced from the upper flange, the lower flange terminating at respective distal end portions at either side of the car. The car includes a side sill running along the car between the first and second end sections. The side sill has an upper flange, the upper flange of the side sill being substantially co-planar and connected to the shear plate. The side sill has a lower flange, the lower flange of the side sill being substantially co-planar with a respective one of the distal end portions of the lower flange of the main bolster. In another further feature, the shear plate defines an upper flange of the draft sill whereby the draft sill upper flange, the shear plate and the side sill upper flange are all substantially co-planar. In another feature the machinery space is free of elephant ears.

In a further aspect of the invention there is a railroad freight car having a freight car body for carrying lading, the body being mounted on railroad car trucks for rolling motion in a longitudinal direction along railroad tracks. The car body includes a draft sill having a draft gear pocket for accommodating draft gear, and a shear plate overlying the draft sill and functioning as an upper flange of the draft sill. The draft sill has an inboard end oriented toward a truck center of one of the trucks, and an outboard end terminating at a striker. The draft sill has an underside and an access opening formed in the underside to admit entry of draft gear into the draft gear pocket from below. The car has a draft gear carrier plate. The carrier plate is mounted to the underside of the draft sill beneath the draft gear pocket. The carrier plate is removable to permit installation of the draft gear into the draft gear pocket. The car body has one of (a) an aperture formed in the shear plate over an inboard end region of the draft sill, the aperture permitting a portion of the draft gear to protrude upwardly therethrough during installation in the draft gear pocket; and (b) a coupler carrier seat defined in the draft sill longitudinally inboard of the striker, and a coupler carrier co-operable therewith, the coupler carrier being removable to permit installation of draft gear in the draft pocket, and, when the coupler carrier is installed, the coupler carrier providing a support for a coupler shank when the coupler shank is connected to the draft gear within the draft sill.

In another feature of that aspect of the invention the freight car has both (a) and (b). In another feature, there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In still another feature, the draft sill has a pair of vertically oriented, longitudinally running spaced apart side webs. The webs have a greater depth of section adjacent to the striker. The webs have respective first and second apertures formed therein. The first and second apertures define the draft gear retainer seat, and the retainer is a sideways slidable shaft that is movable to extend across the draft sill between the first and second apertures in the draft sill side webs. In a further feature there is a cover plate for the aperture of the shear plate, the cover plate being removable to permit installation of the draft gear. In another further feature the draft sill has a centerplate centered on the truck center, rear draft stops are welded within the draft sill, and at least a portion of each of the rear draft stops extends longitudinally inboard of the truck center. In still another further feature, the car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of less than 50 inches; and (b) the freight car has a truck center to coupler pulling face length of less than 65 inches when the draft gear is fully extended in draft. In another feature, the railroad freight car is one in which at least one of (a) the freight car has a truck center to striker plate draft sill length of about 38 inches (+/−2"); and (b) the freight car has a truck center to coupler pulling face length of about 53 inches (+/−2") when the draft gear is fully extended in draft.

These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations.

BRIEF DESCRIPTION OF THE FIGURES

The description is accompanied by a set of illustrative Figures in which:

FIG. **1** is a general arrangement, isometric view of a railroad freight car according to an aspect of the invention with all ancillary systems removed to leave only primary structure visible;

FIG. **2***a* is an isometric view of a sidewall of the gondola car of FIG. **1**;

FIG. **2***b* shows a side view of the sidewall of FIG. **2***a;*

FIG. **2***c* shows an end view of the sidewall of FIG. **2***a;*

FIG. **3***a* shows a perspective view of the end structure of the railroad freight car of FIG. **1**;

FIG. **3***b* is a side view of the structure of FIG. **3***a;*

FIG. **3***c* is a detail of the end structure of FIG. **3***b*, with the near side web of the draft sill removed to show the draft stop, center plate, and coupler relationship.

FIG. **4***a* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully open position;

FIG. **4***b* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in an intermediate position;

FIG. **4***c* is a isometric view of a portion of the door opening mechanism for the railroad car of FIG. **1** in a fully closed position;

FIG. **5***a* is a side view of the door opening mechanism of FIG. **4***a;*

FIG. **5***b* is a side view of the door opening mechanism of FIG. **4***b;*

FIG. **5***c* is a side view of the door opening mechanism of FIG. **4***c;*

FIG. **6***a* is an end view of the door opening mechanism of FIG. **4***a;*

FIG. **6***b* is an end view of the door opening mechanism of FIG. **4***b*; and

FIG. **6***c* is an end view of the door opening mechanism of FIG. **4***c;*

FIG. **7***a* is a perspective view of a secondary lock mechanism for the door opening mechanism of FIG. **4***a;*

FIG. **7***b* is a plan view of the mechanism of FIG. **7***a;*

FIG. **7***c* is a perspective view of the mechanism of FIG. **7***a* when the door are open

FIG. **7***d* is a view similar to FIG. **7***c*, of the mechanism of FIG. **7***a* in a deflected condition; and

FIG. **7***e* is a perspective view of the mechanism of FIG. **7***a* in a locked position;

DETAILED DESCRIPTION

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the present invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings may be taken as being to scale unless noted otherwise.

The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the rail road industry in North America. Following from decision of the CAFC in *Phillips v. AWH Corp*., the Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record in accordance with In re Lee, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years experience in the industry in North America or in other former territories of the British Empire and Commonwealth.

In terms of general orientation and directional nomenclature, for rail road cars described herein the longitudinal direction is defined as being coincident with the rolling direction of the rail road car, or rail road car unit, when located on tangent (that is, straight) track. In the case of a rail road car having a center sill, be it a stub sill or a straight-through center sill, the longitudinal direction is parallel to the center sill, and parallel to the top chords. Unless otherwise noted, vertical, or upward and downward, are terms that use top of rail, TOR, as a datum. In the context of the car as a whole, the term lateral, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the railroad car, or car unit, or of the centerline of a centerplate at a truck center. The term "longitudinally inboard", or "longitudinally outboard" is a distance taken relative to a mid-span lateral section of the car, or car unit. Pitching motion is angular motion of a railcar unit about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the rail road car described herein may tend to have both longitudinal and transverse axes of symmetry, a description of one half of the car may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. In this description, the abbreviation kpsi stands for thousand of pounds per square inch. To the extent that this specification or the accompanying illustrations may refer to standards of the Association of American Railroads (AAR), such as to AAR plate sizes, those references are to be understood as at the earliest date of priority to which this application is entitled.

Bottom dumping hopper cars, of which ore cars and coal cars may be examples, may tend to have either longitudinal doors or transverse doors. Longitudinal doors are oriented such that the doors operate on hinges or axes of rotation that are parallel to the direction of travel of the railroad car generally. U.S. Pat. No. 4,250,814 of Stark et al., issued Feb. 17, 1981 and U.S. Pat. No. 3,800,711 of Tuttle, issued Apr. 2, 1974 show cars with longitudinal doors. By contrast, transverse doors are ones in which the axes of rotation of the hinges or other pivots tend to be predominantly cross-wise to the direction of travel, most often perpendicular to it. An example of a transverse door car shown in U.S. Pat. No. 4,843,974 of Ritter et al, issued Jul. 4, 1989.

FIG. **1** shows an isometric view of an example of a rail road freight car **20** that is intended to be representative of a range of rail road cars in which one or more of the various aspects of the present invention may be incorporated. While car **20** may be suitable for a variety of general purpose uses, it may be taken as being symbolic of, and in some ways a generic example of, a flow through car, in which lading is introduced by gravity flow from above, and removed by gravity discharge through gated or valved outlets below. Flow through, or center flow cars may include open topped hopper cars, grain cars, plastic pellet cars, potash cars, ore cars, coal gondolas, and so on. In one embodiment car **20** may be a hopper car such as may be used for the carriage of bulk commodities in the form of a granular particulate, be it in the nature of relatively coarse gravel or fine aggregate in the nature of fine gravel or sand or various ores, ore concentrate or coal. The principle, or primary, structure of car **20** may be symmetrical about both its longitudinal and transverse, or lateral, centerline axes. Consequently, it will be understood that the car has first and second, left and right hand side beams, bolsters and so on.

By way of a general overview, car **20** may have a car body **22** that is carried on trucks **24** for rolling operation along railroad tracks. Car **20** may be a single unit car, or it may be a multi-unit car having two or more car body units, where the multiple car body units may be substantially permanently connected at an articulated connector, or by draw bars, as opposed to by ordinarily releasable AAR couplers. Car body **22**, and the various structural members and fittings described herein may be understood to be typically of metal construction, whether welded or Huck(t.m.) bolted, or riveted together, the metal members being most typically steel, stainless steel, or aluminum, as may be appropriate. Some car builders have also used reinforced plastic composites for car

elements, and those materials could also be employed where suitable. The default construction may be taken as being steel, of which the majority may be mild steel having, typically, a 50 kpsi yield. Car body **22** may have a lading containment vessel or shell **26** such as may include an upstanding wall structure **28** which may have a pair of opposed first and second end walls **30**, **32**, that extend cross-wise, and a pair of first and second side walls **34**, **36** that extend lengthwise, the end walls **30**, **32** and side walls **34**, **36** co-operating to define a generally rectangular form of peripheral wall structure **28**. Wall structure **28** may include top chords **38** running along the top of the walls, and side sills **40** running fore-and-aft along lower portions of the side sheets or side sheet assemblies **42** of side walls **34**, **36**. In some instances, such as that of the illustration of FIG. **1***a*, car **20** may have stub center sills **44** at either end, in which case side walls **34**, **36** may act as deep beams, and may carry vertical loads to main bolsters **90** that extend laterally from the centerplates. In the case of a single, stand alone car unit, draft gear and releasable couplers may be mounted at either end of the stub center sill. In a center flow, or flow through car, the upper portion of the car may typically include means by which to admit lading under a gravity drop system. Such an intake **46**, or entryway may be a large rectangular opening such as that bounded by top chords **38**.

Car body **22** may include end sheets **48** and side sheets **50**. Car **20** of FIG. **1** et seq., is illustrated as a car having a single hopper **52**, a single hopper discharge section **54**, and an outflow or discharge governor in the nature of a discharge door assembly **56**. However, car **20** could, alternatively, be a multiple hopper car. In a multiple hopper car, the car may have laterally extending members or reinforcements, which may be cross-bearers, or cross-bearers with shrouds, or merely shrouds, particularly where the car is a multiple hopper car. These cross-members may run fully across the car from side sill to side sill, and may intersect the center sill, or the center sill shroud as may be. The car may also include upper wall bracing, in the nature of diagonal struts which extend diagonally upwardly and outwardly from the apices of the respective cross-members at the centerline of the car to upper regions of the side walls near or at the top chords; and lateral ties or struts that run across the car from sidewall to side wall to meet the upper ends of the diagonal struts at their wall brackets. Those brackets may be aligned with, and mated through the wall to, the vertical exterior posts that run from the side sill to the top chord and reinforce the walls.

End sheets **48** may be substantially planar slope sheets or slope sheet assemblies that are inclined downwardly in the longitudinally inboard direction to feed the discharge section. Not atypically, each pair of fore- and aft opposed slope sheets may be inclined at equal and opposite angles, and the angles of those sheets may be selected to be somewhat steeper than the free slope angle, or natural talus slope angle of the lading for which the car is designed, such that, when the gates are opened, the lading may tend to flow out, rather than sit at rest.

The primary structure of body **22** of car **20** includes lading containment vessel **26** which is in the nature of hopper **52**. Hopper **52** has an upper portion **58** with substantially vertical wall panels, and a lower stationary portion defined by a set of converging sloped walls, namely the side and end slope sheet assemblies **48** and **50**. At the lower margin of the sloped walls there is the outflow governor, namely door assembly **56**, which, in this instance, may have the form of a pair of first and second, or left and right hand doors **62**, **64**. This containment structure seats on, and is carried by, a pair of first and second end structures, **66**, **68**, at either end of the car. End structures **66**, **68** are in turn carried by trucks **24**. A door operating apparatus or mechanism, or drive train, or transmission, however it may be termed, and identified generally as **70**, is provided to move doors **62**, **64** between open and closed positions.

Considering this structure in greater detail, trucks **24** are most immediately surmounted by center plates **72** of longitudinally extending stub sills **44**. Stub sills **44** in turn carry laterally extending main bolster arms **74** of main bolster **90**. Arms **74** extended perpendicularly away from the centerplate **72**, i.e., they are centered on the truck center, CL-Truck. Side sills **40** run lengthwise along the car between, and tie together, the most laterally outboard extremities of main bolster arms **74**. A shear plate **76** is mounted in an x-y horizontal plane defining the top cover plate of stub sill **44**. Shear plate **76** extends laterally from side sill to side sill, and longitudinally from the fore-and-aft end slope sheet **48** to the laterally extending end sill **78** of the car, which, in this instance may be an upturned flange formed on the longitudinally outboard margin of shear plate **76**. In car **20**, the primary structure includes an end post **80** and a pair of side or corner posts **82**, **84**.

End post **80** is rooted in shear plate **76** in line with center sill **44**, and may have lateral webs or gussets aligned with the webs of stub sill **44** to provide vertical web continuity across shear plate **76**. End post **80** then extends fully between shear plate **76** and top chord **86** of end wall **30** or **32**, as may be. Corner posts **82** and **84** are rooted to, and stand upwardly from, the junction of the laterally outboard ends of left and right hand main bolster arms **74** and side sills **40**. Posts **82** and **84** extend upwardly from this junction to mate with various elements of the end and side walls, as may be described below.

As described in additional detail below, car **20** has an abnormally short distance from the striker **88** to the truck center, i.e., the CL of centerplate **72**. Striker **88** is the vertical planar surrounding face plate at the outboard end of the stub sill **44**. In the terminology of the industry, the portion of the center sill **44** (be it a stub center sill or a straight through center sill) that lies longitudinally outboard of the truck center CL-Truck may also be referred to as the draft sill. In car **20**, the short draft sill length, identified as L_{88}, leaves an anomalously small space in which to install other systems, such as the brake reservoir and the door operating pneumatic cylinder. Car **20** has an end of car machinery space, indicated generally as **75**, that is bounded by shear plate **76** on the bottom, the sloped end wall assembly **30** or **32** of the car on the top, main vertical central end post **80**, and main side posts **82**, **84** at the ends of main bolster **90**. This space may be referred to as having the shape, generally, of a triangular prism and is substantially unobstructed by the primary structure of the car. For the purposes of this description, primary structure is defined as the underframe, including side sills and center sill (i.e., including the draft sill), the side walls, the slope sheets and top chords, the hopper construction including the stationary parts of the discharge section, as well as any cross-bearers, cross-ties, bolsters, shear plates and so on. Primary structure excludes secondary or ancillary structure or systems such as ladders, cat-walks and other safety appliances, brakes, brake rods and brake fittings, air hoses, reservoirs and pneumatic fittings, movable door members, door operating linkages, and so on.

In existing cars, this space, **75**, is often occupied or otherwise obstructed by other primary structure, such as so-called "elephant ears". In this context, "elephant ears" are large, substantially triangular planar plates, sometimes provided with central lightening holes, that have one edge fixed along the junction of the center sill webs and the center sill cover plate, and another edge welded to the end slope sheet. The

third edge is typically a free edge. Often these plates lie in a plane that is oriented at an angle to the vertical—i.e., it leans laterally outboard. Car **20** avoids the use of these "elephant ears" and so provides the large unobstructed space shown in FIG. **1***b*.

FIGS. **1** and **2***a*, **2***b* and **2***c*, all show the sidewall of the car, indicated generally as **34** or **36**. Sidewall **34** and **36** function as short beams of low (e.g., less than 4:1, possibly less than 3:1) length-to-depth ratio. Sidewall **34** or **36** can be seen to have a bottom flange or chord member, namely side sill **40**, a top flange or chord member, namely top chord **38**, which may have the form of a square or rectangular hollow structural steel tube; and an intermediate shear force transfer web, namely side sheet assembly **42**. Side sheet assembly **42** may include an upper sheet portion or member **92** that is welded to the outside face of top chord **38** at a lap joint, and that extends downwardly therefrom; and a lower sheet portion or member **94**. Member **94** may have the form of a Z-section, having a first portion, namely an upper flange or leg or margin **96** that extends in a substantially vertical plane and has an uppermost margin that overlaps the lowermost edge or margin of member **92**; a second or intermediate portion **98** that runs in an inclined plane sloping inwardly and downwardly on the slope of the hopper side sheets generally, and a third or bottom portion, namely bottom flange, or leg, or margin **100** that extends in a substantially vertical plane downwardly. Sidewall **34** or **36** also includes a central post, or web stiffener, **102** that has a lowermost first portion **104** an intermediate second portion **106**, and an uppermost third portion **108**.

Side sill **40** includes a channel **110** that is welded toes-inward against the lowermost marginal portion of lower leg **100** to form a closed section. The first or lowermost portion **104** of web stiffener **102** has the form of a quadrilateral gusset having a first edge welded to the upper leg of channel **110**, a second edge welded to the vertical margin **100**, a third edge welded to the sloping portion **98**, and the fourth, laterally outboard, edge being free. As may be noted, portion **104** stands outboard of the sidewall sheet.

Portion **108** is a rectangular web stiffener that is welded to, and extends downwardly from, the underside of top chord **38** along the inside face of vertical web portion **92**. Intermediate portion **106** is a web, or plate, or gusset, that is also a quadrilateral, having a first edge that overlaps, and is welded to, the lower margin of portion **108**. A second edge is welded to the lower region of vertical web portion **92**, and to the upper flange or leg **96**. A third edge is welded along the sloped portion **98** of member **94**. The fourth edge is free, and faces inwardly into the lading containment space of the hopper. Portions **104** and **106** are co-planar, or substantially co-planar, such that stiffener **102** has web continuity through member **94**. The upper margin of the side slope sheet **50** of the hopper discharge section is welded to the lower margin of the inclined or sloped portion **98**, such that the structure presents a continuous sloped surface for containing, and then slidingly discharging, particulate lading. Expressed differently, the web of the sidewall traverses the sidewall stiffener, commencing on its inboard margin at side sill **40**, traverses the web mid-way up the post, and ends along its outboard margin at top chord **38**. In this arrangement, the vertical stiffener, **102**, acts as the web of a T-section, and the local region of the wall section to which it is joined functions as the flange of that T-section.

In this example, the locus of intersection of the side slope sheet plane P_{94} with the plane of the side wall sheet P_{92}, lies above the level of side sill **40** by a substantial distance, indicated as L_{94}. This distance may lie in the range of ¼ to ⅔ of the distance L_{SW} from side sill **40** to top chord **38**, and, in the particular may be about ⅓ of that distance. Further, although the post has stiffening member web continuity in a vertical plane, the wall sheet traverses the stiffening web intermediate the top chord and the side sill, and does so obliquely on the slope of plane P_{94}.

The upper leg of channel **110** forms the upper flange of side sill **40**, and the lower leg of channel **110** forms the lower flange of side sill **40**. Shear plate **76** forms the top flange of main bolster **90**. Main bolster **90** also has a lower or bottom flange **91**. In car **20** the upper leg of channel **110** is co-planar or substantially co-planar with, and is connected in flange continuity with, shear plate **76**. Similarly, the lower leg of channel **110** is co-planar or substantially co-planar with, and connected in flange continuity with, bottom flange **91** of main bolster **90**.

Continuing with the sidewall assembly, the main sheet, namely upper sheet portion **92**, ends at the corners, and there are respective first and second end upper web stiffener portions and inwardly stepped plate members **112**, which may be termed "ears". The top edge of each ear is welded to the inside face of top chord **38** in a lap joint. The longitudinally outboard end edge forms a plane to which the vertical end sheet of the end slope sheet wall abuts and is welded. The bottom edge follows the slope of, and is welded to, end slope sheet **48**. The forward, transversely outwardly bent edge is welded to the upper end portion of side sheet assembly **42**. The lower region of the main sidewall sheet also includes lightening apertures **114**, in the space between the corner posts and the slope of the end slope sheets. Finally, the lower portion of region **100** of the main sidewall sheet has longitudinal extensions **116** that are welded to the side edges of the shear panel, namely shear plate **76**, outboard of main bolster **90**, thereby forming a portion of the peripheral flange of the shear plate.

End walls **30**, **32** each include upper and lower sloped surface members **122** and **124**, which could be made as a single piece, or as two pieces butt-welded together, as here. Upper member **122** has notches **126** formed therein to accommodate corresponding corner posts **82**, **84** as may be, with local reinforcement doublers **128** at the junction. Lower portion **124** tapers in width to match the narrowing width between the sloped side sheets with which it mates. At the upper end of end wall **30** the end wall assembly includes a laterally extending first formed member **130** that has a first, vertical leg **132** that laps the inside face of the top chord **86**, and a bent flange **136** that extends initially horizontally, with a distal lip bent upward to mate perpendicularly with the upper margin **138** of the end slope sheet **48**. The distal tip of end slope sheet **48** is fillet welded to vertical leg **132**. This results in a substantially triangular closed section defining a laterally extending end slope sheet reinforcement beam **140**. The ends of this beam abut, are welded to, and are capped by elephant ears **112**. Vertical leg **132** also lies against, and is welded to, end post **80**.

A formed angle **142** is mounted toes-in at an intermediate height on sloped end wall **48**, forming thereby another hollow section laterally extending end sheet reinforcement or beam **148**. Vertical leg **144** of angle **142** is substantially aligned with the central web of the corner post (be it **82** or **84**) and therefore also with the central web of the main bolster. Another formed angle **150** is welded toes-in to the back of sloped end wall **30** at the level of shear plate, thereby forming yet another slope-sheet reinforcement in the form of a laterally extending beam.

The corner posts **82** and **84** each have a lower corner post flange plate **160** (that includes a lifting lug aperture) that has a bottom tab welded to the outside, or back, of the end of side sill **40** in line with the main bolster, then an angled portion following the angle of the outside edge of the vertically

extending side wall reinforcements, **161**, to an upper end at the juncture of the side slope sheet with the side wall vertical leg of the lower side wall sheet. Each end post has two internal reinforcements **154**. Each corner post also includes an intermediate member, or web, or gusset, or plate **162**, which is considerably wider than intermediate gusset **106**, and a substantially triangular inside edge web stiffener **164**. Plate **162** is a quadrilateral. A first edge of plate **162** runs along the upward and outward slope of wall extension **166**. A second edge runs vertically against the upper leg of wall extension **166**. A third upper edge adjacent runs horizontally along lateral reinforcement beam **148**. The fourth edge runs vertically downward to and along edge stiffener **164**. As such, a vertical post is established.

Considering FIGS. **3***a*, **3***b* and **3***c*, center sill **44** includes a bottom flange or bottom cover plate **165**, and a pair of spaced apart webs **168**. The central region of shear plate **76** forms the top flange, or top cover plate of the center sill. At its inboard end, the center sill terminates centrally under the bottom lateral reinforcement of the end slope sheet **48**. A draft pocket **175** is defined between webs **168**, shear plate **76** and bottom cover plate **165** longitudinally inboard of the striker plate.

Center plate **72** is mounted at truck center CL-Truck, in line with main bolster **90** and the corner posts **82**, **84**. Rear draft stops **172** are welded within the center sill above center plate **72**. As seen in FIG. **3***c*, the inboard end of rear draft stop **172** extends longitudinally inboard of the truck center. While this is known to have been used in at least one single piece, integrally cast draft sill, the inventor is unaware of such a construction in an all-welded fabrication draft sill assembly. The removable draft sill access cover plate, or draft gear carrier plate **174**, which is bolted to the draft sill (i.e., the stub sill) bottom flange margins, is mounted immediately longitudinally outboard of center plate **72**. Front draft stops **176** are, in turn, mounted longitudinally outboard of carrier plate **174**. In this embodiment there is also a removable member, such as a top leeway or access plate **178**, mounted to shear plate **76**. Plate **178** is removed when draft gear **180** is removed or installed. On installation, draft gear **180**, to which yoke **188** is already mounted, is fed into draft pocket **175** from below, on an angle, whereby the rear corner protrudes upwardly through the opening that is otherwise covered by plate **178**. The front end of draft gear **180** is rotated into place, and the rear end is rotated downward. As this occurs, yoke **188** is also raised into place. Plates **178** and **174** are then reinstalled. The shank **182** of the coupler, **184** is inserted, and the coupler key **186** is fed through the slot in front draft stops **176** to link coupler **184**, and yoke **188** in the customary manner. It may be noted that coupler **184** combines an AAR Type E shank with and AAR Type F knuckle with a bottom shelf. Draft gear **180** itself has abnormally short travel, namely about 2½ inches deflection before going solid, as compared to a "normal" deflection of over 3" before going solid.

Draft sill webs **164** have, at their longitudinally outboard end an end portion **190** of increased depth of section with a downwardly protruding bulge or horn, such as might be termed a "chin". End portion **190** has an aperture or slot **192** formed therein to permit lateral sliding insertion of a coupler support, carrier or bar **194** immediately behind striker plate **88**. Removal of bar **194** permits yoke **188** to be swung into place during installation of draft gear **180**. When coupler **184** is installed, the shank may rest on bar **194**. Bar **194** is held in place by bolts that secure it relative to webs **164**. Overall, a coupler installation of very short length is achieved. In this example, L_{88} may be in the range of less than 50 inches, and in one embodiment may be about 38"+/−2", from the truck center to the outboard face of striker plate **88**. An alternative expression of the relative compactness of the draft gear is that the length from the truck center to the pulling face of the coupler, when the draft gear is extended in tension, is in the range of less than 65 inches, and in one embodiment is in the range of 53"+/−2".

Car **20** may also include a door opening mechanism **200**. There are left and right hand, or first and second, doors **62**, **64**. Each door has a proximal, hinged edge **206**, and a distal free edge **208**. The hinges are carried on hinge fittings welded to mounting brackets depending from the slope sheets and side sills. The hinges run parallel to the longitudinal or lengthwise axis of the car, generally such that doors **62**, **64** are longitudinal doors. Each door has the form of a hollow section beam, having a proximal beam **210** along the hinge side, a distal beam **212** along the free edge, internal cross-braces, not shown, and front and back skins or sheets or plates **214**, **216**. The hinges are indicated as **220**, the end closure plates as **222**, **224**. The doors have door seal members **226**, **228** that mutually engage when the doors are moved to a closed position. Seal members **226**, **228** are sprung, such that when they are closed they deflect somewhat and in so doing take on a spring pre-load against each other. The door mechanism includes a pair of first and second, matched left and right hand pivot arms **230**, **232**; a corresponding pair of first and second drag links **234**, **236**; a shared yoke **238**, and a pair of slave links **240**, **242** that each pick up on a knuckle fitting **244**, **246** of each of respective doors **62**, **64**. The whole assembly has left and right hand symmetry.

Inasmuch as, when tripped, doors **62**, **64** open under the influence of gravity, particularly when assisted by the weight of the lading being discharged, one may consider the motion that occurs as the doors are closed in the sequence of views **4***a*, **4***b*, and **4***c*; **5***a*, **5***b*, and **5***c*; and **6***a*, **6***b* and **6***c*. Knuckles **244** and **246** are constrained by geometry to move in circular arcs of fixed radii in planes perpendicular to the respective axes of rotation of doors **62** and **64**, those axes being the hinge axes of their respective hinges **220**, which each lie in a plane parallel to the x-z plane of the car centerline. The plane of rotation of knuckles **244**, **246** will then tend to be perpendicular to the central x-z plane. Slave links **240** and **242** are each of fixed length; each has an end pivotally connected at a two rotational degree of freedom knuckle, be it **244** or **246**, as may be; each of slave links **240** and **242** has another end pivotally connected at a second pivot connection at yoke **238**; and slave links **240** and **242** do not transmit a bending moment, and so therefore pull in pure tension. The upper, or near (i.e., proximal), ends of drag links **234**, **236** are connected to the distal ends of pivot arms **230**, **232** at pivot connections **248**, **250**, which may, if desired, share a common axis of rotation or pivot pin.

Yoke **238** is constrained by symmetry to pull in an x-z plane, which in the embodiment illustrated is the vertical plane of the centerline of the car. As such, movement of yoke **238** away from the plane of motion of knuckles **244** and **246** will necessarily draw knuckle fittings **244** and **246** closer together, and toward the vertical centerline plane of the car, eventually causing resilient door seals **226**, **228** mutually to engage, thus closing the opening. This motion can be achieved by pulling on drag links **234**, **236**. Each pivot connection of slave links **240**, **242** has a single angular degree of freedom. Similarly yoke **238** has an angular degree of freedom about the axis of rotation of the axle, or trunnions, by which it is pivotally mounted to the drag link, or drag links **234**, **236**. This gives the drag link connection two angular degrees of freedom in total. As the drag links are withdrawn, the slave links pull in tension, finding the natural hypotenuse between the plane of the arc of motion of knuckle fittings **244**,

246 and the plane of motion of drag links 234, 236. Since this mechanism operates in tension, pivot connections 248, 250 and knuckle fittings 244, 246 are co-planar, with drag links 234, 236, yoke 238, slave links 240 and 242, and their associated pivot connections also lying in that same plane as well. (See FIGS. 5*a*, 5*b*, 5*c*).

Driving force for this system is provided by an actuator, identified as 260. Actuator 260 may be a pneumatic actuator, which may be charged by the pneumatic system of the train generally, as supplied through the pressurized air connection of the train line. Actuator 260 may include its own reservoir and check valve. Actuator 260 is connected to move a first member, in the nature of a primary driven pivot arm or lever, 262, which is in this instance actually a pair of matched lever arm members, which in turn is pivotally connected to, and drives, a second member in the nature of, a push rod, or, given the symmetrical nature of the assembly, a pair of left and right hand push rods 264 and 266. One or both of push rods 264, 266 may have a secondary member, such as may be an extending arm, or detent, or stop, or abutment, identified as an over-center travel limiter or governor, 268. The far ends of push rods 264, 266 may be connected to either pivot arms 230 (or 232, as may be), or to drag link 234 (or 236, as may be). It may be convenient to connect the far end of push rods 264, 266 at the same pivot connection, or connections 248, 250.

Lever 262 has a first end pivotally mounted to primary structure of car 20 at footings, identified as mounting fixtures, fittings or brackets 270. The drive rod of actuator 260 picks up on lever 262 at an intermediate location, such that lever 262 provides magnification of displacement. Similarly, pivot arms 230, 232 have a first or base end pivotally connected to primary structure at mounting fixtures, fittings, or brackets 272. Actuator 260 is located on the centerline (i.e., in the central x-z plane) of car 20, between and in substance below pivot arms 230, 232. "Below" in this context may be thought of as radially more proximate to the pivot axis P_{270} of brackets 270 than is the pivot axis of connections 248, 250, as well as in the context of being lower than as in closer to Top of Rail. In the past the lever fitting has more commonly been mounted to the slope sheet such that the output pin is lower than the pneumatic cylinder. Turning this arrangement upside down, in effect, and fitting the cylinder may then permit a more compact installation than otherwise. Similarly, the pivot axis, P_{230}, of driven arms 230, 232 is below the output knuckle, i.e., at P_{250}, and is below the actuator cylinder as shown in FIG. 5*b* in which P_{250} lies below the center line CL_{260} or actuator 260. This may be taken in the sense of being further from the plane of the end slope sheets, identified as P_{48}. Expressed differently, actuator 260 lies between the base or datum pivot point P_{250} of driven arms 230, 232 and the plane P_{48} of end slope sheet 48.

As may be noted, the line of action of drag links 234, 236 has a predominant component that is substantially parallel to plane P_{48}. Expressed differently, at some point during midstroke, the line of action will be at least instantaneously parallel to plane P_{48}. Finally, it may be noted that rather than placing actuator 260 on shear plate 76, and orienting actuator 260 such that its longitudinal axis (i.e., the working axis or axis of reciprocation of the actuator), that actuator is itself raised upwardly from the shear plate and oriented to work along a line of action that is tilted downward and longitudinally inboard, the angle of tilt being identified as α_{260}. This angle of inclination lies in the range from horizontal to the angle of inclination of end slope sheet 48, identified in FIG. 5*c* as α_{48}. Placing the mounts and pivot points under the apparatus, raising the actuator cylinder, orienting it on an incline, and making the line of action or the zone swept by the draglinks in the progressions of FIGS. 4*a*, 4*b* and 4*c* (or 5*a*, 5*b* and 5*c*) tend to correspond to a displacement substantially or predominantly parallel to plane P_{48}, all aid in providing a more compact installation, in particular one that is longitudinally short as may suit the short distance from the truck center to the striker. It is also an installation that may tend to leave space for other car systems, such as the brake system.

This arrangement may be thought of in terms of a four bar, or multi-bar, linkage. The first bar of the linkage may be thought of as being the underframe, and structure rigidly mounted to the underframe. This is the datum, or frame of reference member of the linkage. The second member or linkage component is the first pivot arm, 230 (or 232) having a fixed main pivot point, and an output distal pivot point constrained to move on a fixed radius about main pivot point P_{230}. The fourth component or element of the linkage is the second pivot arm, namely 62 or 64, each of which is a second lever or pivot arm mounted to a pivot axis fixed with respect to the first or datum link, and having a distal connection, in this case also a pivot connection, constrained to move in an arc of constant radius about the base pivot axis. The third linkage is the drag link. Although the drag link is made of two portions that are held together at yoke 238, the geometric symmetry of the assembly constrains both the upper portion of the drag link, (i.e., drag link 234, 236) and the lower portions, (i.e., slave links 240, 242) to be co-planar during closing of the doors. In any case, the single input of the actuator cylinder acting through the over-center links against the first pivot arm (at the distal pivot connection) produces a unique output geometry such that position of the elements is determinate as if it were a four bar linkage.

When the door opening apparatus is retracted to the position shown in FIGS. 4*c*, 5*c* and 6*c*, driven primary pivot arms and the over-center links are driven to a slightly over-center relationship such that the pivot connection between the primary pivot arms and the over center arms lies below a line drawn from the primary pivot axis and the over-center link output connection as axis P_{250}. In this condition tensile force on drag links 234 and 236 (as from weight placed on doors 62, 64, for example) will tend to urge the main driven pivot arms, namely lever 262, counter-clockwise as viewed in FIG. 4*c*. Motion in this direction is prevented by the over center stop, 268, thereby defining a first lock that prevents inadvertent opening of doors 62, 64 from moving to the open position when actuator 260 is dormant, i.e., inactive. This first lock is released by reversing actuator 260 to open the doors.

Car 20 has a secondary door mechanism, or secondary latching system, identified generally as 300. This secondary latch system, and, indeed, the door closure linkage apparatus of FIGS. 7*a*-7*e*, are slightly different from those shown in FIGS. 4*a*, 5*a*, and 6*a*. In latching system 300 there is a latch assembly 302, shown in FIGS. 7*a* and 7*b*. Assembly 302 includes a first member, or main member, or plate 304, which performs the function of a body or armature or spider that ties the other various physical elements of the assembly together. Along one edge plate 304 has physical motion constraint fittings, identified as hinge fittings 306, that limit plate 304 (and assembly 302 more generally) to a single degree of freedom, that single degree of freedom limiting plate 304 to motion of any point to motion in a plane perpendicular to the hinge axis, and in particular to pivotal motion in that plane about that axis. To the extent that the hinge axis is substantially or predominantly parallel to the axis of reciprocation of pneumatic actuator 260, that motion can be said to be sideways, or predominantly transverse of cross-wise to that direction of reciprocation.

Plate **304** has a portion or finger, or arm member **308** extending away from the hinge. In this case, arm member **308** extends arcuately away, and has a bent termination, or end, or lip, or tip, indicated at **310**. Another member **312** in the form of a block is mounted, e.g., welded, at the distal end of arm member **308**. Member **312** has the same general shape, a dog-leg bend, as tip **310**. Member **312** has a first, generally inwardly (i.e., away from the tip) facing surface **314** that defines an abutment **316**. Member **312** also has an oblique surface **318** that defines a wear or cam surface, which may be termed a reset cam, or return cam.

Another member **320**, which may have the form of a plate or block, is welded to the major portion of the body of plate **304** relatively close to the hinge axis. The axially foremost face of member **322** is relieved—i.e., it does not define a face in a plane perpendicular to the hinge axis—or to the axis of reciprocation of the pneumatic actuator clevis. This face may be arcuate or chamfered, and so defines a first or deflection cam **324**. That is, as installed, it lies in the path of actuator clevis **330**. When the leading corner of clevis **330** encounters cam **324**, plate **304** will tend to be urged to rotate, i.e., pivot, about its axis in the clockwise direction as viewed looking from actuator **260** toward hopper **52**. Assembly **302** also includes a motion resisting, or return biasing member in the form of a spring, identified as leaf spring **326** that is anchored at the proximal end to stationary structure of the secondary lock footing, or base, **328** which is welded to shear plate **76**. The footprint of base **328** against shear plate **76** is planar. The hinge axis is inclined relative to the plane as shown, the angle of inclination being substantially similar to, and possibly the same as, the mid-stroke angle of inclination of actuator **260** (which, itself, varies slightly during operation). The distal end of spring **326** bears against plate **304** distant from the hinge. Finally, assembly **302** includes reaction force transmission members **332**, **334** in the form of welded flat bars that bear against, i.e., abut, the longitudinally outboard face of mounting fitting **270** when the latch is in the engaged position.

In operation, as actuator **260** works, lost motion is taken up in slot **336** of the distal or forward end **338** of the reciprocating actuator ram. Eventually the end of slot **336** engages a pivot pin **340** of bell crank arm **342** and causes driven member **344** (analogous to driven member **262**), causing it to rotate counterclockwise as viewed in FIG. **7***a*. This forces push rods **346**, **348** (analogous to push rods **264**, **266**) to act against connections **248**, **250**, and hence to force drag links **234**, **236** along their retracting path. Since **262**, **264**, **230** and the car body form a four bar linkage, the output path of connections **248**, **250** is determinate and unique.

While this happens, clevis **338** keeps moving rearward to engage reset cam surface **318**, with the effect that assembly **302** is urged to rotate out of the way, against the resistance of spring **326** (FIG. **7***d*). Eventually the trailing portion of clevis **338** clears cam **324**, and soon thereafter the most longitudinally inboard edge of driven member **344** clears abutment **316**. Assembly **302** then moves under the influence of spring **326** into the locked position shown in FIG. **7***e*. In this locked position, any moment tending to pivot driven member **344** clockwise is reacted not by the hinge fittings, but rather by the reinforcements, namely members **332**, **334**. In this locked position driven member **344** and push rods **346**, **348** are drawn to, and locked in, their over center position.

When the doors are to be released, actuator **260** moves in the opposite direction. The lost motion of the length of slot **336** reverses, such that the end of clevis **338** bears against the release cam, namely cam surface **324**, which causes plate **304** to pivot away, and thus disengages abutment **316**, moving it out of the path of driven member **262** against which it would otherwise abut. The outboard end of slot **336** then engages pin **340**, releasing the over-center hold of driven member **344**, and permitting the doors to open under the influence of gravity.

The cams need not necessarily be on the plate, i.e., the latch body, but could be on the clevis, as shown at **350** in FIG. **4***c*. That is, it is to some extent arbitrary which part is identified as the cam, and which part is identified as the cam follower. The point is that the parts mutually engage such that the one intercepts the other during motion of the actuator cylinder to trip the door opening condition, with the result that the secondary latch is urged to deflect out of the way sideways. In the other direction, of course, the abutment relationship of items **262** and **316** prevents the doors from opening. The apparatus of FIG. **4***c* works in substantially the same way, and combines both arms of the bell crank driven member **344** into a single driven lever, namely lever **262**.

In summary, car **20** has a first lock, the over center lock, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive. Car **20** also has a second lock, symbolized by latching system **300**, operable to prevent movement of the door from the closed position to the open position when the door actuator is inactive if the first lock should fail. The second lock is movable between an engaged position in which it prevents movement of the door to the open position thereof. In moving between the engaged and disengaged positions, the second lock has a displacement that is predominantly cross-wise to the first direction of the reciprocation of the door actuator. Actuator **260** is positioned to reciprocate in the central lengthwise-vertical plane of car **20**. Latching system **300** is movable predominantly transverse to the central lengthwise-vertical plane as it pivots in a circumferential direction between the engaged and disengaged positions. The hinge axis lies parallel to the lengthwise vertical plane, and the second lock pivots circumferentially. The second lock is biased toward the engaged position. The lock mechanism can be thought of as having a first fitting, a second fitting and a third fitting. The first fitting is the mounting, **238** by which to connect the lock mechanism to the datum structure. The second fitting is one of a cam or a cam follower for co-operation with a member of the door actuating transmission. The third fitting is the abutment, i.e., **316**, that co-operates with a mating part of the door actuating transmission, in this case the side of lever **262**. The third fitting is movable between a first position and a second position, in the first position the abutment being presented to obstruct motion of the mating fitting of the door actuating transmission and thereby to prevent the door from moving to an open position thereof. The second fitting is movable between a first position and a second position, in the first position thereof the second fitting being positioned to intercept the member of the door actuating transmission and to be deflected away from the first position toward the second position thereby. The first fitting has a first degree of freedom of motion permitting the first and second fittings to move between their respective first and second positions. The degree of freedom constrains the third fitting to motion predominantly cross-wise to the axial direction. The bias member is a spring having a first end and a second end, the first end being mounted to bear against the body of the lock mechanism, the second end having a foot for reaction against the datum structure, namely shear plate **76**. The first degree of freedom of motion is an angular degree of freedom, and is predominantly cross-wise circumferential motion. The axis of rotation is the hinge axis, which is substantially parallel to the axial direction of the door actuating transmission.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

We claim:

1. A railroad hopper car for carrying particulate material, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and first and second end slope sheets oriented toward said first and second end sections, said end slope sheets being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over hanging said shear plate of said first end section; and

said hopper car being free of primary structure directly above said shear plate of said first end section under said overhang of said first end slope sheet of said hopper;

one of:

(a) said first end slope sheet has an upper margin and said hopper car includes an end post extending upwardly from said draft sill to said upper margin of said first end slope sheet; and

(b) said first end slope sheet has an upper margin terminating at an end wall, and said hopper car includes an end post extending upwardly from draft stub sill to said end wall;

said shear plate has a longitudinally outboard margin and said draft sill has a striker located outboard of said longitudinally outboard margin of said shear plate, and said end post is one of:

(a) rooted to said draft sill adjacent to said striker;

(b) rooted to said shear plate adjacent to said longitudinally outboard margin of said shear plate;

said bolster has first and second laterally outboard distal ends, and said hopper car has corner posts extending upwardly from said distal ends of said bolster to said first end slope sheet; and

said hopper car has a machinery space bounded by (a) said first end slope sheet; (b) said shear plate of said first end section; (c) said end post; and (d) said corner posts, and said machinery space is free of any other primary structure.

2. The railroad hopper car of claim **1** wherein said bolster has first and second laterally outboard distal ends, and said hopper car has corner posts extending upwardly from said distal ends of said hopper to said first end slope sheet.

3. The railroad hopper car of claim **1** wherein:

said hopper car has at least one longitudinally hinged discharge door, said discharge door being movable cross-wise between open and closed positions; and

a longitudinally acting pneumatic actuator is at least partially lodged in said machinery space directly above said draft sill.

4. The railroad hopper car of claim **3** wherein a brake reservoir is also at least partially lodged in said machinery space.

5. The railroad hopper car of claim **1** wherein:

said shear plate is mounted above, and to, said main bolster and defines an upper flange thereof;

said main bolster has a lower flange downwardly spaced from said upper flange, said lower flange terminating at respective distal end portions at either side of said car;

said car includes a side sill running along said car between said first and second end sections;

said side sill has an upper flange, said upper flange of said side sill being substantially co-planar with, and connected to, said shear plate; and

said side sill has a lower flange, said lower flange of said side sill being substantially co-planar with a respective one of said distal end portions of said lower flange of said main bolster.

6. The railroad hopper car of claim **5** wherein said shear plate defines an upper flange of said draft sill whereby said draft sill upper flange, said shear plate and said side sill upper flange are all substantially co-planar.

7. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

a first laterally extending reinforcement mounted cross-wise to said first end slope sheet adjacent to said shear plate;

said shear plate of said first end section being connected to said first laterally extending reinforcement;

said first end slope sheet of said first end section being connected to said first laterally extending reinforcement;

said first laterally extending reinforcement defining part of a first hollow section beam extending across said hopper car between said first and second side walls;

said hopper car being free of longitudinally oriented elephant ears extending between said draft sill and said end slope sheet;

said hopper car has a first end wall member running cross-wise between said first and second side walls;

said first end slope sheet has an upper margin that meets said first end wall member at a first junction;

said first end wall member extends upwardly from said first junction;

said first end wall member has a lower portion extending downward of said first junction;

said lower portion of said first end wall member and said upper margin of said first end slope sheet co-operate to define portions of the cross-section of a second hollow section beam extending cross-wise across said hopper car between said first and second side walls.

8. The railroad hopper car of claim **7** wherein said laterally extending reinforcement member includes a first edge mounted cross-wise along said first end slope sheet; a second edge mounted cross-wise along said first end slope sheet and spaced from said first edge, and a third portion mounted across said shear plate of said first end section.

9. The railroad hopper car of claim **7** wherein said laterally extending member has a pair of first and second spaced apart toes, and said laterally extending member is mounted toes-in against said first end slope sheet, whereby said first hollow section beam is defined by said laterally extending reinforcement and said first end slope sheet.

10. The railroad hopper car of claim **7** wherein said laterally extending reinforcement has, when seen in section, a first toe, a second toe, and a back; said laterally extending reinforcement is mounted toes-in against said first end slope sheet; and said back is mounted to said shear plate of said first end section.

11. The railroad hopper car of claim **10** wherein said laterally extending reinforcement is an angle iron mounted toes-in to said first end slope sheet.

12. The railroad hopper car of claim **7** wherein said lower portion of said first end wall member has a lower margin that is bent to meet said upper margin of said first end slope sheet at a location lower than said first junction.

13. The railroad hopper car of claim **7** wherein said first end wall member has an upper margin that terminates at a top chord, said top chord extending from side to side of said hopper car.

14. The railroad hopper car of claim **7** wherein said car includes an upstanding end post, said end post being mounted over said draft sill longitudinally outboard of said main bolster and extending upwardly therefrom to meet said first end wall member.

15. The railroad hopper car of claim **7** wherein an intermediate beam extends across said first end slope sheet between said first and second side walls at a position intermediate said first hollow section beam and said second hollow section beam.

16. The railroad hopper car of claim **15** wherein said intermediate beam includes a cross-wise extending structural member mounted toes-in against said first end slope sheet to define a closed hollow section.

17. The railroad hopper car of claim **7** wherein said first and second side walls of said hopper car define sidewalls of said hopper, and said first and second side walls include end portions that are stepped laterally inboard, and said second hollow section beam extends between said end portions of said first and second side walls that are stepped laterally inboard.

18. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

a first laterally extending reinforcement mounted cross-wise to said first end slope sheet adjacent to said shear plate;

said shear plate of said first end section being connected to said first laterally extending reinforcement;

said first end slope sheet of said first end section being connected to said first laterally extending reinforcement;

said first laterally extending reinforcement defining part of a first hollow section beam extending across said hopper car between said first and second side walls;

said hopper car being free of longitudinally oriented shear webs ears extending between said draft sill and said end slope sheet;

said hopper car has second, and third hollow section beams as well as said first hollow section beam, said first, second and third hollow section beams extending thereacross between said first and second side walls thereof;

said first end slope sheet has an uppermost margin, and said second hollow section beam runs along said uppermost margin of said first end slope sheet;

said third hollow section beam is located intermediate said first and second hollow section beams;

said hopper car has an end post mounted over said draft sill, said end post being located longitudinally outboard of said main bolster of said first end section;

said end post extends upwardly to meet said second hollow section beam;

said hopper car has first and second side sills running longitudinally along either side thereof, said first and second side walls extending upwardly of said first and second side sills respectively;

said first and second side sills mate with first and second ends of said main bolster of said first end section; and

said first and second side sills have upper flanges that mate with said shear plate of said first and section.

19. The railroad hopper car of claim **18** wherein:

there is an end wall that extends from sidewall to sidewall;

said end wall has an upper portion that has an upper margin terminating at a top chord of said end wall;

said first end slope sheet has an uppermost margin, said uppermost margin of said first end slope sheet meeting said end wall along a first juncture;

said end wall has a lower portion extending below said first juncture, said lower portion being bent to define a portion of said second hollow section beam; and

said end post extends past said second hollow section beam along said end wall to mate with said top chord of said end wall.

20. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end

slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate mounted to said draft sill and to said main bolster, said shear plate extending lengthwise along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet of said hopper over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

a first laterally extending reinforcement mounted cross-wise to said first end slope sheet adjacent to said shear plate;

said shear plate of said first end section being connected to said first laterally extending reinforcement;

said first end slope sheet of said first end section being connected to said first laterally extending reinforcement;

said first laterally extending reinforcement defining part of a first hollow section beam extending across said hopper car between said first and second side walls;

said hopper car being free of longitudinally oriented elephant ears extending between said draft sill and said end slope sheet;

said main bolster of said first end section of said railroad hopper car has first and second ends at laterally outboard extremities thereof;

said hopper car has first and second corner posts mounted at said first and second ends of said main bolster of said first end section, said corner posts extending upwardly from said main bolster to said first end slope sheet;

said draft sill has a longitudinally outboard end;

an end post stands upwardly of said longitudinally outboard end of said draft sill;

a machinery space is defined above said shear plate, below said first end slope sheet, longitudinally inboard of said end post, and between said corner posts; and

said machinery space is free of any other primary structure.

21. The railroad hopper car of claim **20** wherein:

said hopper has a movable door by which egress of lading is governed;

said hopper car has an actuator and a drive train, said drive train being connected between said actuator and said door, said actuator being operable to move said door; and

said actuator is mounted in said machinery space.

22. The railroad hopper car of claim **21** wherein said first side wall has an aperture formed therein at a location higher than said shear plate, lower than said first end slope sheet, and longitudinally inboard of said first corner post.

23. The railroad hopper car of claim **20** wherein

said first and second side walls of said car have openings defined therein longitudinally inboard of said respective corner posts, above said shear plate, and below said first end slope sheet.

24. A railroad hopper car, said hopper car comprising:

a hopper;

first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;

said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;

said first end section including a draft sill extending in the longitudinal direction, a main bolster extending cross-wise to said draft sill, and a shear plate overlying said draft sill and said main bolster, said shear plate extending along said draft sill and cross-wise from side to side of said hopper car;

said first end slope sheet over-hanging said shear plate of said first end section;

first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;

there being a first end wall extending between said first and second side walls;

said first end slope sheet having an uppermost margin, said uppermost margin meeting said first end wall at a first junction;

said hopper car having a first beam extending cross-wise between said first and second side walls at said first junction of said uppermost margin of said first end slope sheet and said first end wall, said first beam being a beam of hollow section;

said first end wall has an upper portion and a lower portion;

said upper portion of said first end wall extends upwardly of said first junction of said uppermost margin of said first end slope sheet and said first end wall;

said lower portion of said end wall extends downwardly of said first junction of said uppermost margin of said first end slope sheet and said first end wall; and

said lower portion of said first end wall forms part of said first beam;

said draft sill having longitudinally extending draft sill webs;

said first end section being free of longitudinally oriented elephant ears extending upwardly of said draft sill webs to meet said end slope sheet;

said lower portion of said first end wall has a margin, and said margin is bent to mate with said first end slope sheet as a second junction distant from the first junction, said lower portion of said first end wall and said uppermost margin of said first end slope sheet co-operating to define said first beam.

25. The railroad hopper car of claim **24** wherein an end post is mounted over said draft sill outboard of said main bolster, said end post extending upwardly to meet said first beam.

26. The railroad hopper car of claim **25** wherein:

said upper portion of said first end wall extends upwardly of said first junction to end at a top chord; said top chord extends across said hopper car between said first and second side walls; and

said end post extends past said first beam to terminate at said top chord.

27. The railroad hopper car of claim **25** wherein:

said main bolster has first and second ends; and

respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom.

28. The railroad hopper car of claim **27** wherein: a machinery space is defined above said shear plate, in the lee of said first end slope sheet, longitudinally inboard of said end post and between said first and second corner posts; and said machinery space is free of any other primary structure.

29. The railroad hopper car of claim 28 wherein:
said first side wall has an aperture formed therein in a location that is longitudinally inboard of said first corner post, above said shear plate, and leeward of said first end slope sheet;
said hopper has a movable gate operable to govern egress of lading from said hopper;
there is an actuator mounted in said machinery space, and a drive train connecting said actuator to said gate.

30. The railroad hopper car of claim 24 wherein a second beam is mounted across said first end slope sheet adjacent said shear plate.

31. The railroad hopper car of claim 30 wherein a third beam is mounted across said first end slope sheet intermediate said first and second beams, and said third beam is formed of a structural member mounted toes-in against said first end slope sheet to define an hollow section.

32. A railroad hopper car, said hopper car comprising:
a hopper;
first and second end sections for carriage by respective first and second rail road car trucks for rolling motion along railroad tracks in a longitudinal direction;
said hopper being suspended between said first and second end sections, said hopper having a discharge section through which to release lading, and a first end slope sheet oriented toward said first end section, said first end slope sheet being inclined in the longitudinal direction to feed said discharge section;
said first end section including a draft sill extending in the longitudinal direction, said draft sill having first and second spaced apart longitudinally running draft sill webs and a draft pocket defined therebetween;
said first end section including a main bolster extending cross-wise to said draft sill;
said first end section having a truck center where said main bolster meets said draft sill;
said draft sill having a striker end longitudinally outboard of said truck center;
said first end section including a shear plate;
said shear plate overlying said draft sill webs and said main bolster, said shear plate extending longitudinally along said draft sill and cross-wise from side to side of said hopper car;
said shear plate having an outboard margin running across said car distant from said truck center and proximate said striker end;
said first end slope sheet over-hanging said shear plate of said first end section;
first and second side walls running lengthwise along first and second sides of said car, said first end slope sheet of said hopper extending cross-wise between said first and second side walls;
there being a first end wall extending between said first and second side walls;
said first end slope sheet having an uppermost margin, said uppermost margin meeting said first end wall at a first junction;
said hopper car having a first beam extending cross-wise between said first and second side walls at said first junction of said uppermost margin of said first end slope sheet and said first end wall, said first beam being a beam of hollow section;
said first end wall is surmounted by a cross-wise running top chord;
said first end wall includes a panel extending downwardly from said cross-wise running top chord;
said first end section includes an end post extending upwardly of said draft sill, said end post being mounted above said draft sill distant from said truck center and proximate said striker end;
said end post extending upwardly to meet said first beam and said top chord;
said first end section being free of longitudinally oriented elephant ears extending upwardly of said draft sill webs of said draft sill to meet said first end slope sheet; and
said hopper car having a second beam extending cross-wise between said first and second side walls, said second beam being a beam of hollow section; and
said second beam being connected to said shear plate.

33. The railroad hopper car of claim 32 wherein a third beam is mounted across said first end slope sheet intermediate said first and second beams.

34. The railroad hopper car of claim 33 wherein said third beam is formed of a structural member mounted toes-in against said first end slope sheet to define an hollow section.

35. The railroad hopper car of claim 32 wherein:
said main bolster has first and second ends; and
respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom to meet said first end slope sheet.

36. The railroad hopper car of claim 35 wherein:
a machinery space is defined above said shear plate and under said first end slope sheet; and
a door actuator is mounted above said shear plate and under said first end slope sheet.

37. The railroad hopper car of claim 35 wherein:
a machinery space is defined above said shear plate and under said first end slope sheet;
said first side wall has an aperture formed therein in a location that is longitudinally inboard of said first corner post, above said shear plate, and leeward of said first end slope sheet;
said hopper has a movable gate operable to govern egress of lading from said hopper;
there is an actuator mounted in said machinery space, and a drive train connecting said actuator to said gate.

38. The railroad hopper car of claim 32 wherein:
said main bolster has first and second ends; and
respective first and second corner posts are mounted to said first and second ends of said main bolster and extend upwardly therefrom;
said first side wall has an opening formed therein, said opening being located longitudinally inboard of said first corner post, upward of said shear plate, leeward of said first end slope sheet.

39. The railroad hopper car of claim 32 wherein said draft sill has a longitudinally outboard end, and a striker plate mounted at said longitudinally outboard end; and said draft sill has a length between said truck center and said striker plate that is less than 50 inches.

40. The railroad hopper car of claim 32 wherein
said railroad hopper car has first and second end section, and said hopper is carried thereby;
said first and second side walls each have a respective side sill and a top chord;
said first side wall extends from said side sill to said top chord;
said first side wall has a predominantly upwardly running side wall stiffener mounted thereto, said side wall stiffener being located at a longitudinal station intermediate the trucks;
said first side wall having a first region, said first region being a lower region thereof;

said first side wall having a second region, said second region being an upper region thereof;

said side wall stiffener having a first portion, said first portion being a lower portion thereof;

said first portion being mounted to said first region of said first side wall;

said side wall stiffener having a second portion, said second portion being an upper portion thereof, said second portion being mounted to said second region of said side wall;

said first portion of said first side wall stiffener being laterally outboard of said first region of said first side wall;

said second portion of said side wall stiffener being laterally inboard of said second region of said first side wall;

said side wall having a continuous section between said first and second regions thereof; and

said side wall stiffener having web continuity between said first and second portions thereof.

41. The railroad hopper car of claim **40** wherein said first and second portions of said side wall stiffener are substantially co-planar, and are substantially vertically aligned when seen in a sectional view looking along the car.

42. The railroad hopper car of claim **41** wherein said first side wall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said side wall stiffener from an inboard margin thereof to an outboard margin thereof, and said stiffener having vertical web continuity through said transition portion.

43. The railroad hopper car of claim **40** wherein:

said first side wall has a third region intermediate said first and second regions, said third region including a side sheet transition portion passing across said side wall stiffener from an inboard margin thereof to an outboard margin thereof;

said hopper includes first and second sloped side sheets; and

said first sloped side sheet meets said first side wall at said transition portion.

44. The railroad hopper car of claim **43** wherein said first side wall has an overall height from said side sill to said top chord, L, and said transition portion is located a distance above said side sill that is in the range of ¼ to ⅔ L.

* * * * *

EXHIBIT A3

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF DELAWARE

NATIONAL STEEL CAR LIMITED, Plaintiff, v. FREIGHTCAR AMERICA, INC., Defendant.	)))))))))	C.A. No. 24-594-JLH-CJB

AGREED PROTECTIVE ORDER
REGARDING THE DISCLOSURE AND USE OF DISCOVERY MATERIAL

Plaintiff National Steel Car Limited ("NSC") and Defendant FreightCar America, Inc. ("FreightCar America") anticipate that documents, testimony, or information containing or reflecting confidential, proprietary, trade secret, and/or commercially sensitive information are likely to be disclosed or produced during the course of discovery, initial disclosures, and supplemental disclosures in this case and request that the Court enter this Order setting forth the conditions for treating, obtaining, and using such information.

Pursuant to Rule 26(c) of the Federal Rules of Civil Procedure, the Court finds good cause for the following Agreed Protective Order Regarding the Disclosure and Use of Discovery Material ("Order" or "Protective Order").

1. PURPOSES AND LIMITATIONS

(a) Protected Material designated under the terms of this Protective Order shall be used by a Receiving Party solely for this case, and shall not be used directly or indirectly for any other purpose whatsoever.

(b) The Parties acknowledge that this Order does not confer blanket protections on all disclosures during discovery, or in the course of making initial or supplemental disclosures under Rule 26(a). Designations under this Order shall be made with care and shall not be made absent a good faith belief that the designated material satisfies the criteria set forth below. If it comes to a Producing Party's attention that designated material does not qualify for protection at all, or does not qualify for the level of protection initially asserted, the Producing Party must promptly notify all other Parties that it is withdrawing or changing the designation.

(c) Other Proceedings. By entering this order and limiting the disclosure of information in this case, the Court does not intend to preclude another court from finding that information may be relevant and subject to disclosure in another case. Any person or party subject to this order who becomes subject to a request or motion that would require disclosure of another party's information designated "CONFIDENTIAL" or "CONFIDENTIAL – ATTORNEYS' EYES ONLY" pursuant to this Order shall promptly notify that party of the request or motion so that the party may have an opportunity to appear and be heard on whether that information should be disclosed.

2. DEFINITIONS

(a) "Affiliate" means any corporation, company, or other business entity over which a Party has the power to direct or cause the direction of the management, policies, or legal actions through: (1) at least 50% ownership of voting securities; or (2) contract; or (3) other means.

(b) "Discovery Material" means all items or information, including from any non-party, regardless of the medium or manner generated, stored, or maintained (including, among other things, testimony, transcripts, or tangible things) that are produced, disclosed, or generated in connection with discovery or Rule 26(a) disclosures in this case.

(c) "Outside Counsel" means (i) outside counsel of record in this case for a Party and (ii) partners, associates, and staff of such counsel to whom it is reasonably necessary to disclose the information for this litigation.

(d) "Patents in suit" means U.S. Patent Nos. 8,132,515 and 8,166,892 and any other patent asserted in this case, as well as any related patents, patent applications, provisional patent applications, continuations, and/or divisionals.

(e) "Party" means any party to this case, including all of its officers, directors, employees, consultants, vendors, retained experts, and outside counsel and their support staffs.

(f) "Producing Party" means any Party or non-party that discloses or produces any Discovery Material in this case.

(g) "Protected Material" means any Discovery Material that is designated as "CONFIDENTIAL" or "CONFIDENTIAL – ATTORNEYS' EYES ONLY," as provided for in this Order. Protected Material shall not include: (i) advertising materials that have been actually published or publicly disseminated; and (ii) materials that show on their face they have been disseminated to the public.

(h) "Receiving Party" means any Party who receives Discovery Material from a Producing Party.

3. COMPUTATION OF TIME

The computation of any period of time prescribed or allowed by this Order shall be governed by the provisions for computing time set forth in Federal Rules of Civil Procedure 6.

4. SCOPE

(a) The protections conferred by this Order cover not only Discovery Material governed by this Order as addressed herein, but also any information copied or extracted

therefrom, as well as all copies, excerpts, summaries, or compilations thereof, plus testimony, conversations, or presentations by Parties or their counsel in court or in other settings that might reveal Protected Material.

(b) Nothing in this Protective Order shall prevent or restrict a Producing Party's own disclosure or use of its own Protected Material for any purpose, and nothing in this Order shall preclude any Producing Party from showing its Protected Material to an individual who prepared the Protected Material.

(c) Nothing in this Order shall be construed to prejudice any Party's right to use any Protected Material with the consent of the Producing Party or by order of the Court.

(d) This Order is without prejudice to the right of any Party to seek further or additional protection of any Discovery Material or to modify this Order in any way, including, without limitation, an order that certain matter not be produced at all.

(e) Any use of Protected Material at trial shall be governed by the orders of the trial judge and other applicable authorities. This Order does not govern the use of Protected Material at trial.

5. DURATION

Even after the termination of this case, the confidentiality obligations imposed by this Order shall remain in effect until a Producing Party agrees otherwise in writing or a court order otherwise directs.

6. ACCESS TO AND USE OF PROTECTED MATERIAL

(a) Basic Principles. All Protected Material shall be used solely for this case or any related appellate proceedings, and not for any other purpose whatsoever. Protected Material

shall not be distributed, disclosed, or made available to anyone except as expressly provided in this Order.

(b) Patent Prosecution Bar. After the adoption of this provision by the parties, Outside Counsel and any person associated with a Party who receives a Producing Party's material designated "CONFIDENTIAL – ATTORNEYS' EYES ONLY" under this Protective Order or who has access to, accesses, or otherwise learns of, in whole or in part, said material designated "CONFIDENTIAL – ATTORNEYS' EYES ONLY" under this Protective Order shall not prepare, prosecute, supervise, advise, counsel, or assist in the preparation or prosecution of any patent application seeking a patent on behalf of the Receiving Party or its acquirer, successor, predecessor, or Affiliate in the field of railcars (generally or as described in any patent in suit) during the pendency of this action and for two years after final termination of this action, including all appeals. To avoid any doubt, "prosecution" as used in this section does not include representing or advising a Party before a domestic or foreign agency in connection with a reissue, ex parte reexamination, covered business method review, inter partes review, opposition, cancelation, or similar proceeding; though in connection with any such foreign or domestic agency proceeding, any attorney who has access to, accesses, obtains, receives, or otherwise learns, in whole or in part, any other Party's "CONFIDENTIAL – ATTORNEYS' EYES ONLY" material shall not: (i) participate in the preparation, prosecution, supervision, advice, counsel, or assistance of any amended claims; (ii) reveal a Producing Party's Protected Material to any prosecuting reexamination counsel or agent; or (iii) use a Producing Party's Protected Material for any purpose not permitted by Section 1.

(c) Secure Storage. Protected Material must be stored and maintained by a Receiving Party in a secure manner that ensures that access is limited to the persons authorized under this Order.

(d) Legal Advice Based on Protected Material. Nothing in this Protective Order shall be construed to prevent counsel from advising their clients with respect to this case based in whole or in part upon Protected Materials, provided counsel does not disclose the Protected Material itself except as provided in this Order.

(e) Limitations. Nothing in this Order shall restrict in any way a Producing Party's use or disclosure of its own Protected Material. Nothing in this Order shall restrict in any way the use or disclosure of Discovery Material by a Receiving Party: (i) that is or has become publicly known through no fault of the Receiving Party; (ii) that is lawfully acquired by or known to the Receiving Party independent of the Producing Party; (iii) previously produced, disclosed and/or provided by the Producing Party to the Receiving Party or a non-party without an obligation of confidentiality and not by inadvertence or mistake; (iv) with the consent of the Producing Party; or (v) pursuant to order of the Court.

7. DESIGNATING PROTECTED MATERIAL

(a) Available Designations. Any Producing Party may designate Discovery Material with any of the following or comparable designations, provided that it meets the requirements for such designations as provided for herein: "CONFIDENTIAL" or "CONFIDENTIAL - ATTORNEYS' EYES ONLY."

(b) Written Discovery and Documents and Tangible Things. Written discovery, documents (which include "electronically stored information," as that phrase is used in Federal Rule of Procedure 34), and tangible things that meet the requirements for the

confidentiality designations listed in Section 7(a) may be so designated by placing the appropriate designation on every page of the written material prior to production. For digital files being produced, the Producing Party may mark each viewable page or image with the appropriate designation, and mark the medium, container, and/or communication in which the digital files were contained. In the event that original documents are produced for inspection, the original documents shall be presumed "CONFIDENTIAL – ATTORNEYS' EYES ONLY" during the inspection and re-designated, as appropriate during the copying process.

(c) Native Files. Where electronic files and documents are produced in native electronic format, such electronic files and documents shall be designated for protection under this Order by appending to the file names or designators information indicating whether the file contains "CONFIDENTIAL" or "CONFIDENTIAL – ATTORNEYS' EYES ONLY" material, or shall use any other reasonable method for so designating Protected Materials produced in electronic format. When electronic files or documents are printed for use at deposition, in a court proceeding, or for provision in printed form to an expert or consultant pre-approved pursuant to Section 10, the party printing the electronic files or documents shall affix a legend to the printed document corresponding to the designation of the Producing Party and including the production number and designation associated with the native file. The parties reserve the right to object to the use of any image format version of a document produced in native format to the extent any information has been altered or omitted.

(d) Depositions and Testimony. Parties or testifying persons or entities may designate all or portions of depositions and other testimony with the appropriate designation by indicating on the record at the time the testimony is given or by sending written notice of how portions of the transcript of the testimony are designated within thirty (30) days of receipt of the

transcript of the testimony. If no indication on the record is made, all information disclosed during a deposition shall be deemed "CONFIDENTIAL – ATTORNEYS' EYES ONLY" until the time within which it may be appropriately designated as provided for herein has passed. Any Protected Material that is used in the taking of a deposition shall remain subject to the provisions of this Protective Order, along with the transcript pages of the deposition testimony dealing with such Protected Material. In such cases the court reporter shall be informed of this Protective Order and shall be required to operate in a manner consistent with this Protective Order. In the event the deposition is videotaped, the original and all copies of the videotape shall be marked to indicate that the contents of the videotape are subject to this Protective Order, substantially along the lines of "This videotape contains confidential testimony used in this case that is not to be viewed, displayed, or revealed except pursuant to the terms of the operative Protective Order in this matter or pursuant to written stipulation of the parties." Counsel for any Producing Party shall have the right to exclude from oral depositions, other than the deponent, deponent's counsel, the reporter and videographer (if any), any person who is not authorized by this Protective Order to receive or access Protected Material based on the designation of such Protected Material. Such right of exclusion shall be applicable only during periods of examination or testimony regarding such Protected Material.

8. DISCOVERY MATERIAL DESIGNATED AS "CONFIDENTIAL"

(a) A Producing Party may designate Discovery Material as "CONFIDENTIAL" if it contains or reflects confidential, proprietary, and/or commercially sensitive information.

(b) Unless otherwise ordered by the Court, Discovery Material designated as "CONFIDENTIAL" may be disclosed only to the following:

(i) The Receiving Party's Outside Counsel, such counsel's immediate paralegals and staff, and any copying or clerical litigation support services working at the direction of such counsel, paralegals, and staff;

(ii) Officers or employees of the Receiving Party, who may be, but need not be, in-house counsel for the Receiving Party, as well as their immediate paralegals and staff, to whom disclosure is reasonably necessary for this case, provided that each such person has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(iii) Any outside expert or consultant retained by the Receiving Party to assist in this case, provided that disclosure is only to the extent necessary to perform such work; and provided that: (a) such expert or consultant has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; (b) such expert or consultant is not a current officer, director, or employee of a Party or of a competitor of a Party, nor anticipated at the time of retention to become an officer, director or employee of a Party or of a competitor of a Party; and (c) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Section 10 below;

(iv) Witnesses at depositions or hearings in this case and the witnesses' counsel, provided however that the disclosure shall only be made to: (1) a witness who is an employee of the Producing Party; (2) a witness who is identified on the document as an author, addressee, or recipient of the material in question, or if there are other indicia (such as from metadata, cover emails, or other records of distribution) that the witness has seen or had access to the document previously; or (3) a witness who has been designated to testify on behalf of the Producing Party on the subject matter of the material in question, provided

however that the Protected Material shown to such a witness shall be limited to Protected Material of the Producing Party;

(v) Court reporters, stenographers and videographers retained to record testimony taken in this case, and their staff;

(vi) The Court, jury, and court personnel;

(vii) Graphics, translation, design, trial consulting personnel, and/or other professional vendors, having first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(viii) Mock jurors having first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(ix) Any mediator who is assigned to hear these matters, and his or her staff, subject to their agreement to maintain confidentiality to the same degree as required by this Protective Order; and

(x) Any other person with the prior written consent of the Producing Party.

9. DISCOVERY MATERIAL DESIGNATED AS "CONFIDENTIAL – ATTORNEYS' EYES ONLY"

(a) A Producing Party may designate Discovery Material as "CONFIDENTIAL – ATTORNEYS' EYES ONLY" if it contains or reflects information that is extremely confidential and/or sensitive in nature and the Producing Party reasonably believes that the disclosure of such Discovery Material is likely to cause harm or significant competitive disadvantage to the Producing Party. The Parties agree that the following information, if non-public, shall be presumed to merit the "CONFIDENTIAL – ATTORNEYS' EYES ONLY"

designation: trade secrets, pricing information, financial data, sales information, sales or marketing forecasts or plans, business plans, sales or marketing strategy, product development information, engineering documents, testing documents, employee information, and other non-public information of similar competitive and business sensitivity.

(b) Unless otherwise ordered by the Court, Discovery Material designated as "CONFIDENTIAL – ATTORNEYS' EYES ONLY" may be disclosed only to:

(i) The Receiving Party's Outside Counsel and such Outside Counsel's immediate paralegals and staff, and any copying or clerical litigation support services working at the direction of such counsel, paralegals, and staff;

(ii) Any outside expert or consultant retained by the Receiving Party to assist in this case, provided that disclosure is only to the extent necessary to perform such work; and provided that: (a) such expert or consultant has agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A; (b) such expert or consultant is not a current officer, director, or employee of a Party or of a competitor of a Party, nor anticipated at the time of retention to become an officer, director, or employee of a Party or of a competitor of a Party; (c) such expert or consultant is not involved in competitive decision-making, as defined by *U.S. Steel v. United States*, 730 F.2d 1465, 1468 n.3 (Fed. Cir. 1984), on behalf of a Party or a competitor of a Party; and (d) no unresolved objections to such disclosure exist after proper notice has been given to all Parties as set forth in Section 10 below;

(iii) Witnesses at depositions or hearings in this case and the witnesses' counsel, provided however that the disclosure shall only be made to: (1) a witness who is an employee of the Producing Party; (2) a witness who is identified on the document as an author, addressee, or recipient of the material in question, or if there are other indicia

(such as from testimony, metadata, cover emails, or other records of distribution) that the witness has previously seen or had access to the document or the information contained therein; or (3) a witness who has been designated to testify on behalf of the Producing Party on the subject matter of the material in question, provided however that the Protected Material shown to such a witness shall be limited to Protected Material of the Producing Party;

(iv) Court reporters, stenographers and videographers retained to record testimony taken in this action, and their staff;

(v) The Court, jury, and court personnel;

(vi) Graphics, translation, design, trial consulting personnel, and/or other professional vendors, having first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(vii) Mock jurors having first agreed to be bound by the provisions of the Protective Order by signing a copy of Exhibit A;

(viii) Any mediator who is assigned to hear this matter, and his or her staff, subject to their agreement to maintain confidentiality to the same degree as required by this Protective Order; and

(ix) Any other person with the prior written consent of the Producing Party.

10. NOTICE OF DISCLOSURE

(a) Prior to disclosing any Protected Material to any person described in Sections 8(b)(iii) or 9(b)(ii) (referenced below as "Person"), the Party seeking to disclose such information shall provide the Producing Party with written notice that includes:

(i) the name of the Person;

(ii) an up-to-date curriculum vitae of the Person;

(iii) the present employer and title of the Person; and

(iv) a list of the cases in which the Person has testified at deposition or trial within the last five (5) years.

Further, the Party seeking to disclose Protected Material shall provide such other information regarding the Person's professional activities reasonably requested by the Producing Party for it to evaluate whether good cause exists to object to the disclosure of Protected Material to the outside expert or consultant.

(b) Within ten (10) days of receipt of the disclosure of the Person, the Producing Party or Parties may object in writing to the Person for good cause. In the absence of an objection at the end of the ten (10) day period, the Person shall be deemed approved under this Protective Order. There shall be no disclosure of Protected Material to the Person prior to expiration of this ten (10) day period. If the Producing Party objects to disclosure to the Person within such ten (10) day period, the Parties shall meet and confer via telephone or in person within four (4) days following the objection and attempt in good faith to resolve the dispute on an informal basis. If the dispute is not resolved, the Party objecting to the disclosure will have four (4) days from the date of the meet and confer to seek relief from the Court and shall have the burden of proving the need for a protective order. If relief is not sought from the Court within that time, the objection shall be deemed withdrawn. If relief is sought, designated materials shall not be disclosed to the Person in question until the Court resolves the objection.

(c) For purposes of this Section 10, "good cause" shall include an objectively reasonable concern that the Person will, advertently or inadvertently, use or disclose Discovery Material in a way or ways that are inconsistent with the provisions contained in this Order.

(d) Prior to receiving any Protected Material under this Order, the Person must execute a copy of the "Agreement to Be Bound by Protective Order" (Exhibit A hereto) and serve it on all Parties.

(e) An initial failure to object to a Person under this Section 10 shall not preclude the nonobjecting Party from later objecting to continued access by that Person for good cause not known or not reasonably discoverable by the objecting Party at the time of the disclosure of the Person. Objections for good cause shall be made within seven (7) days of the objecting Party learning such good cause. If an objection is made, the Parties shall meet and confer via telephone or in person within seven (7) days following the objection and attempt in good faith to resolve the dispute informally. If the dispute is not resolved, the Party objecting to the disclosure will have seven (7) days from the date of the meet and confer to seek relief from the Court. The designated Person may continue to have access to information designated under this Order while the Court resolves the matter.

11. CHALLENGING DESIGNATIONS OF PROTECTED MATERIAL

(a) A Party shall not be obligated to challenge the propriety of any designation of Discovery Material under this Order at the time the designation is made, and a failure to do so shall not preclude a subsequent challenge thereto.

(b) Any challenge to a designation of Discovery Material under this Order shall be written, shall be served on Outside Counsel for the Producing Party, shall particularly identify the documents or information that the Receiving Party contends should be differently designated, and shall state the grounds for the objection. Thereafter, further protection of such material shall be resolved in accordance with the following procedures:

(i) The objecting Party shall have the burden of conferring either in person, in writing, or by telephone with the Producing Party claiming protection (as well as any other interested party) in a good faith effort to resolve the dispute. The Producing Party shall have the burden of justifying the disputed designation;

(ii) Failing agreement, the Receiving Party may bring a request or motion to the Court for a ruling that the Discovery Material in question is not entitled to the status and protection of the Producing Party's designation. The Parties' entry into this Order shall not preclude or prejudice either Party from arguing for or against any designation, establish any presumption that a particular designation is valid, or alter the burden of proof that would otherwise apply in a dispute over discovery or disclosure of information;

(iii) Notwithstanding any challenge to a designation, the Discovery Material in question shall continue to be treated as designated under this Order until one of the following occurs: (a) the Party who designated the Discovery Material in question withdraws such designation in writing; or (b) the Court rules that the Discovery Material in question is not entitled to the designation.

12. DATA SECURITY

(a) If the Receiving Party becomes aware of any unauthorized access, use, or disclosure of Protected Materials or devices containing Protected Materials ("Data Breach"), the Receiving Party shall promptly, and in no case later than 48 hours after learning of the Data Breach, notify the Producing Party in writing and fully cooperate with the Producing Party as may be reasonably necessary to (a) determine the source, extent, or methodology of such Data Breach, (b) recover or protect Protected Materials, and/or (c) to satisfy the Producing Party's legal, contractual, or other obligations. For the avoidance of doubt, notification obligations under this

section arise when the Receiving Party both (a) learns of a Data Breach, and (b) learns that any of the Producing Party's Protected Materials are potentially subject to the Data Breach. The notification obligations set forth in this section do not run from the time the Data Breach itself.

(b) If the Receiving Party is aware of a Data Breach, the Parties shall meet and confer in good faith regarding any adjustments that should be made to the discovery process and discovery schedule in this case, potentially including but not limited to (1) additional security measures to protect Discovery Material; (2) a stay or extension of discovery pending investigation of a Data Breach and/or implementation of additional security measures; and (3) a sworn assurance that Discovery Material will be handled in the future only by entities not impacted by the Data Breach.

13. SUBPOENAS OR COURT ORDERS

(a) If at any time Protected Material is subpoenaed by any court, arbitral, administrative, or legislative body, the Party to whom the subpoena or other request is directed shall immediately give prompt written notice thereof to every Party who has produced such Discovery Material and to its counsel and shall provide each such Party with an opportunity to move for a protective order regarding the production of Protected Materials implicated by the subpoena. The Producing Party must also notify in writing the party who caused the subpoena or order to issue in the other litigation that some or all of the material covered by the subpoena or order is subject to this Protective Order, and include a copy of this Protective Order. The parties agree to work together to allow the Producing Party to seek a protective order, after the filing of which the Party served with the subpoena or court order shall not produce any information designated in this action as "CONFIDENTIAL" or "CONFIDENTIAL – ATTORNEYS EYES

ONLY" before a determination on the protective order by the court from which the subpoena or order issued, unless the Party has obtained the Producing Party's permission.

14. FILING PROTECTED MATERIAL

(a) Absent written permission from the Producing Party or a court Order secured after appropriate notice to all interested persons, a Receiving Party may not file or disclose in the public record any Protected Material.

(b) Any Party is authorized under District of Delaware Local Rule 5.1.3 to file under seal with the Court any brief, document or materials that are designated as Protected Material under this Order.

15. INADVERTENT DISCLOSURE OF PRIVILEGED MATERIAL

(a) Pursuant to Federal Rule of Evidence 502(d) and (e), the inadvertent production by a Party of Discovery Material subject to the attorney-client privilege, work-product protection, or any other applicable privilege or protection, despite the Producing Party's reasonable efforts to prescreen such Discovery Material prior to production, will not waive the applicable privilege and/or protection in any other federal or state proceeding if a request for return of such inadvertently produced Discovery Material is made promptly after the Producing Party learns of its inadvertent production. For example, the mere production of a privileged or work product protected document in this case as part of a production is not itself a waiver. Nothing in this Order shall be interpreted to require disclosure of irrelevant information or relevant information protected by the attorney-client privilege, work product doctrine, or any other applicable privilege or immunity. The parties do not waive any objections as to the production, discoverability, admissibility, or confidentiality of documents and ESI. Moreover, nothing in this Order shall be interpreted to require disclosure of information subject to privacy protections as set forth in law or

regulation, including information that may need to be produced from outside of the United States and/or may be subject to foreign laws.

(b) Upon a request from any Producing Party who has inadvertently produced Discovery Material that it believes is privileged and/or protected, each Receiving Party shall immediately return to the Producing Party or securely destroy, at the Producing Party's option, such Protected Material or Discovery Material and all copies, except for any pages containing privileged markings by the Receiving Party which shall instead be destroyed and certified as such by the Receiving Party to the Producing Party.

(c) Nothing herein shall prevent the Receiving Party from preparing a record for its own use containing the date, author, addresses, and topic of the inadvertently produced Discovery Material and such other information as is reasonably necessary to identify the Discovery Material and describe its nature to the Court in any motion to compel production of the Discovery Material.

16. INADVERTENT FAILURE TO DESIGNATE PROPERLY

(a) The inadvertent failure by a Producing Party to designate Discovery Material as Protected Material with one of the designations provided for under this Order shall not waive any such designation provided that the Producing Party notifies all Receiving Parties that such Discovery Material is protected under one of the categories of this Order within ten (10) days of the Producing Party learning of the inadvertent failure to designate. The Producing Party shall reproduce the Protected Material with the correct confidentiality designation within five (5) days upon its notification to the Receiving Parties. Upon receiving the Protected Material with the correct confidentiality designation, the Receiving Parties shall return or securely destroy, at the Producing Party's option, all Discovery Material that was not designated properly.

(b) A Receiving Party shall not be in breach of this Order for any use of such Discovery Material before the Receiving Party receives such notice that such Discovery Material is protected under one of the categories of this Order, unless an objectively reasonable person would have realized that the Discovery Material should have been appropriately designated with a confidentiality designation under this Order. Once a Receiving Party has received notification of the correct confidentiality designation for the Protected Material with the correct confidentiality designation, the Receiving Party shall treat such Discovery Material (subject to the exception in Section 16(c) below) at the appropriately designated level pursuant to the terms of this Order.

(c) Notwithstanding the above, a subsequent designation of "CONFIDENTIAL" or "CONFIDENTIAL – ATTORNEYS' EYES ONLY" shall apply on a going forward basis and shall not disqualify anyone who reviewed "CONFIDENTIAL – ATTORNEYS' EYES ONLY" materials while the materials were not marked "CONFIDENTIAL – ATTORNEYS' EYES ONLY" from engaging in the activities set forth in Section 6(b).

17. INADVERTENT DISCLOSURE NOT AUTHORIZED BY ORDER

(a) In the event of a disclosure of any Discovery Material pursuant to this Order to any person or persons not authorized to receive such disclosure under this Protective Order, the Party responsible for having made such disclosure, and each Party with knowledge thereof, shall immediately notify counsel for the Producing Party whose Discovery Material has been disclosed and provide to such counsel all known relevant information concerning the nature and circumstances of the disclosure. The responsible disclosing Party shall also promptly take all reasonable measures to retrieve the improperly disclosed Discovery Material and to ensure that no further or greater unauthorized disclosure and/or use thereof is made.

(b) Unauthorized or inadvertent disclosure does not change the status of Discovery Material or waive the right to hold the disclosed document or information as Protected Material.

18. FINAL DISPOSITION

(a) Not later than ninety (90) days after the Final Disposition of this case, each Party shall return all Discovery Material of a Producing Party to the respective Outside Counsel of the Producing Party or destroy such Material, at the option of the Producing Party. For purposes of this Order, "Final Disposition" occurs after an order, mandate, or dismissal finally terminating this case with prejudice, including all appeals.

(b) All Parties that have received any such Discovery Material shall certify in writing that all such materials have been returned to the respective Outside Counsel of the Producing Party or destroyed. Notwithstanding the provisions for return of Discovery Material, Outside Counsel may retain one copy of: (1) all pleadings, motions, and briefs (including supporting or opposing memoranda and exhibits), filed with the Court and/or served upon opposing counsel; (2) discovery responses and each transcript of any depositions (and summaries thereof) taken in this action, including all exhibits thereto; (3) all documents or other materials marked as trial exhibits; and (4) all notes, summaries, descriptions, abstracts, or other work product materials prepared in anticipation of or for use in the present action; provided, however that access to confidential information contained in any of the materials identified in subparagraphs (1) through (4), above, shall be limited to counsel of record for their own internal use, and that such information shall not be provided to any non-party without the express prior written permission of counsel of record for the opposing party or pursuant to court order.

19. MISCELLANEOUS

(a) Right to Further Relief. Nothing in this Order abridges the right of any person to seek its modification by the Court in the future. By stipulating to this Order, the Parties do not waive the right to argue that certain material may require additional or different confidentiality protections than those set forth herein.

(b) Termination of Matters and Retention of Jurisdiction. The Parties agree that the terms of this Protective Order shall survive and remain in effect after the Final Determination of the above-captioned matters. The Court shall retain jurisdiction after Final Determination of these matters to hear and resolve any disputes arising out of this Protective Order.

(c) Successors. This Order shall be binding upon the Parties hereto, their successors, and anyone, including law firms, who obtains access to Protected Material.

(d) Right to Assert Other Objections. By stipulating to the entry of this Protective Order, no Party waives any right it otherwise would have to object to disclosing or producing any information or item. Similarly, no Party waives any right to object on any ground to use in evidence of any of the material covered by this Protective Order. This Order shall not constitute a waiver of the right of any Party to claim in this case or otherwise that any Discovery Material, or any portion thereof, is privileged or otherwise non-discoverable, or is not admissible in evidence in this case or any other proceeding.

(e) Modification by Court. This Order is subject to further court order based upon public policy or other considerations, and the Court may modify this Order *sua sponte* in the interests of justice. The United States District Court for the District of Delaware is responsible for the interpretation and enforcement of this Order. All disputes concerning Protected Material, however designated, produced under the protection of this Order shall be resolved by the United States District Court for the District of Delaware.

SHAW KELLER LLP

/s/ Lindsey M. Gellar
John W. Shaw (#3362)
Andrew E. Russell (#5382)
Lindsey M. Gellar (#7202)
1105 North Market Street, 12th Floor
Wilmington, DE 19801
(302) 298-0700
jshaw@shawkeller.com
arussell@shawkeller.com
lgellar@shawkeller.com

Attorneys for Plaintiff National Steel Car Limited

PHILLIPS, MCLAUGHLIN & HALL, P.A.

/s/ David A. Bilson
John C. Phillips, Jr. (#110)
David A. Bilson (#4986)
1200 North Broom Street
Wilmington, DE 19806
(302) 655-4200
jcp@pmhdelaw.com
dab@pmhdelaw.com

Attorneys for Defendant FreightCar America, Inc.

Dated: January 16, 2025

IT IS SO ORDERED this 16th day of January, 2025.

Christopher J. Burke
The Honorable Christopher J. Burke
United States Magistrate Judge

EXHIBIT A

I, _____, acknowledge and declare that I have received a copy of the Protective Order ("Order") in *National Steel Car Limited v. FreightCar America, Inc.*, United States District Court, District of Delaware, C.A. No. 1:24-cv-00594. Having read and understood the terms of the Order, I agree to be bound by the terms of the Order and consent to the jurisdiction of said Court for the purpose of any proceeding to enforce the terms of the Order.

Name of individual: _____

Present occupation/job description: _____

_____

_____

Name of Company or Firm: _____

Address: _____

Dated: _____

_____
[Signature]

EXHIBIT B

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

NATIONAL STEEL CAR LIMITED, Plaintiffs, v. FREIGHTCAR AMERICA, INC., Defendants.	C.A. No. 24-00594-JLH-CJB

FREIGHTCAR AMERICA, INC.'S OBJECTIONS AND RESPONSES TO PLAINTIFF'S FIRST SET OF INTERROGATORIES (NOS. 1–12)

Pursuant to Rules 26 and 33 of the Federal Rules of Civil Procedure and Local Civil Rule 26.1, FreightCar America, Inc. ("FreightCar America"), hereby responds to Plaintiff National Steel Car Limited's ("NSC") First Set of Interrogatories (Nos. 1-12).

GENERAL STATEMENT AND OBJECTIONS

FreightCar America asserts each of the following General Objections to each of NSC's instructions, definitions, and interrogatories. In addition to these General Objections, FreightCar America states specific objections to individual interrogatories, including objections that are not generally applicable to all interrogatories. By setting forth specific objections, FreightCar America is not limiting or restricting these General Objections.

1. FreightCar America objects generally to NSC's definitions and instructions to the extent that they fail to comply with, or attempt to impose obligations in excess of, Rule 33 of the Federal Rules of Civil Procedure and the applicable Local Rules of this Court. FreightCar America will respond to the interrogatories in compliance with the Federal Rules of Civil Procedure and the Local Rules of this Court.

INTERROGATORY NO. 6:

For the Patents-in-Suit, identify the level of technical knowledge, schooling, experience, training, and expertise of a person having ordinary skill in the art of the subject matter of that claim.

RESPONSE TO INTERROGATORY NO. 6:

FreightCar America incorporates its General Statement and Objections. FreightCar America objects that the request to, "[f]or the Patents-in-Suit," identify information regarding the subject matter of "that claim" is vague and ambiguous in the context of this interrogatory. FreightCar America objects to this request as premature because it calls for expert opinions in advance of the deadlines set forth in the Court's scheduling order.

Subject to and without waiving the foregoing general and specific objections, FreightCar America responds as follows:

FreightCar America will seasonably update its response to this interrogatory consistent with the Federal Rules of Civil Procedure, the Local Rules of this Court, and the Court's scheduling order.

INTERROGATORY NO. 7:

Describe in detail the development of each Accused Product from conception to commercialization including how each individual feature has evolved over time, the individuals most knowledgeable about the development of each feature, the beginning and end dates for development, and identify all geographic locations where that product has been designed, manufactured, tested, and imported and when it was designed, manufactured, tested, and imported.

RESPONSE TO INTERROGATORY NO. 7:

FreightCar America incorporates its General Statement and Objections. FreightCar America objects to this interrogatory to the extent it seeks information protected by the attorney-client privilege, work product doctrine, or any other applicable privilege or immunity. To the extent the request that FreightCar America "[d]escribe in detail" the development of each Accused Product seeks every detail thereof, the request is overly broad, unduly burdensome, and not proportional to the needs of the case; FreightCar America will respond at a reasonable level of detail. The requests to describe how "each individual feature" has evolved over time and the individuals most knowledgeable about the development of "each feature" are vague and ambiguous; overly broad, unduly burdensome, and not proportional to the needs of the case; and constitute multiple interrogatories. FreightCar America objects that the request to describe "the beginning and end dates for development" is vague and ambiguous in the context of this interrogatory.

Subject to and without waiving the foregoing general and specific objections, FreightCar America responds as follows:

FreightCar America incorporates its response to Interrogatory No. 1.

FreightCar America began designing and manufacturing railcars in 1901. Since then, FreightCar America has designed and manufactured thousands of railcar models. This includes a broad variety of railcar types for transportation of bulk commodities and containerized freight products, including open top hoppers, covered hoppers, gondolas, box cars, and flat cars. FreightCar America has produced more than 600 models of railcars with open-top hopper and bottom discharge configuration, including several models of ore cars.

These railcars—whether made by FreightCar America or others—have had the same common components for many decades or longer. For example, ore cars made by FreightCar

America and others commonly have a hopper, slope sheets, draft sills, bolsters, shear plates, end posts, corner posts, and strikers.

[redacted]

[redacted]

[redacted] Plate B is an equipment diagram for unrestricted interchange service. Plate B provides the maximum clearance requirements for freight cars meeting Plate B operating in unrestricted interchange.

[redacted] On November 12, 2023, the first Accused Products shipped from FreightCar America's facility in Castaños, Coahuila, Mexico.

FreightCar America designed, manufactured, tested, and imported the Accused Products between 2019 and 2024 at and from FreightCar America's facilities in Johnstown, Pennsylvania and Castaños, and [redacted] FreightCar America's railcar production facility in Castaños is certified by the Association of American Railroads, which sets railcar manufacturing industry standards for quality control. Individuals knowledgeable about the development of the Accused Product include [redacted]

INTERROGATORY NO. 8:

For each Accused Product, state the projected volume of sales in the United States and abroad (delineated by region), by quantity and amount (in dollars) on a month-by-month basis from present through 2031, including the costs and expected profits associated with each sale, and the person(s) most knowledgeable about the marketing and sales for each identified product.

RESPONSE TO INTERROGATORY NO. 8:

DMIR and every single Third Party facility. FreightCar America will respond at a reasonable level of detail.

Subject to and without waiving the foregoing general and specific objections, FreightCar America responds as follows:

FreightCar America incorporates its response to Interrogatory No. 7.

Dated: January 30, 2025

PHILLIPS, MCLAUGHLIN & HALL, P.A.

By: */s/ David A. Bilson*
John C. Phillips, Jr. (#110)
David A. Bilson (#4986)
1200 North Broom Street
Wilmington, DE 19806-4204
Telephone: (302) 655-4200
Facsimile: (302) 655-4210
jcp@pmhdelaw.com
dab@pgmhlaw.com

Attorneys for Defendant FreightCar America, Inc.

Of Counsel

Brian C. Horne (*Pro Hac Vice*)
KNOBBE, MARTENS, OLSON & BEAR, LLP
1925 Century Park East, Suite 400
Los Angeles, CA 90067
Tel: (310) 551-3450
Fax: (310) 601-1263
Brian.Horne@knobbe.com

Sean M. Murray (*Pro Hac Vice*)
Justin J. Gillett (*Pro Hac Vice*)
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, CA 92614
Tel: (949) 760-0404
Fax: (949) 760-9502
Sean.Murray@knobbe.com
Justin.Gillett@knobbe.com

CERTIFICATE OF SERVICE

I hereby certify that on January 30, 2025, a true and correct copy of the within document was served on the following counsel of record at the addresses in the manner indicated:

VIA EMAIL:

John W. Shaw Andrew E. Russell SHAW KELLER LLP I.M. Pei Building 1105 North Market Street, 12th Floor Wilmington, DE 19801 (302) 298-0700 jshaw@shawkeller.com arussell@shawkeller.com	Safet Metjahic Robert D. Keeler ICE MILLER LLP 1500 Broadway, Suite 2900 New York, NY 10036 (212) 824-4940 Metiahic@icemiller.com Robert.Keeler@icemiller.com Kenneth Sheehan ICE MILLER LLP 200 Massachusetts Ave NW, Suite 400 Washington, DC 20001 (202) 807-4055 Ken.sheehan@icemiller.com

Dated: January 30, 2025

/s/ David A. Bilson
David A. Bilson (#4986)